REPORTS

OF THE

UNITED STATES COMMISSIONERS

TO THE

PARIS UNIVERSAL EXPOSITION, 1867.

PUBLISHED

UNDER DIRECTION OF THE SECRETARY OF STATE BY AUTHORITY OF THE SENATE OF THE UNITED STATES.

EDITED BY
WILLIAM P. BLAKE,
COMMISSIONER OF THE STATE OF CALIFORNIA.

VOLUME II.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1870.

CONTENTS

PARIS UNIVERSAL EXPOSITION, 1867.

REPORTS OF THE UNITED STATES COMMISSIONERS.

THE

PRODUCTION OF IRON AND STEEL

IN ITS

ECONOMIC AND SOCIAL RELATIONS.

BY

ABRAM S. HEWITT,

UNITED STATES COMMISSIONER.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1868.

CONTENTS.

SECTION I.

IRON AND STEEL.

BESSEMER STEEL IN AUSTRIA AND PRUSSIA.

Conditions of production similar to those of Sweden—Analyses of the irons and slags—Method of testing the quality—Prices of the steel in various forms.—pp. 81-85.

APPENDICES.

ILLUSTRATIONS.

IRON AND STEEL.

SECTION I.

IRON AND STEEL.

IRON ORES, ROLLED GIRDERS, PLATES, AND RODS.

In the general arrangement of the Universal Exposition of 1867, iron and steel, as products of industry, were placed in the fortieth class of the fifth group. In the distribution of the work of the Commission of the United States, made in conformity with the directions of the Secretary of State, a committee was constituted on "Metallurgy and the extractive arts in general," and to this committee was subsequently assigned, by resolution of the commission, the duty of reporting on "Minerals, as raw materials in the economic arts." The committee consisted of Commissioners Hewitt, D'Aligny, and J. P. Lesley. To Commissioner Lesley was assigned the task of reporting upon "Mining machinery and processes of mining;" to Commissioner D'Aligny, on "Minerals, as raw materials in the economic arts, and on the metallurgy of the precious metals;" and to Commissioner Hewitt "On the production of iron and steel in its economic and social relations."

In the preparation of this report, in order to bring it within reasonable limits, the general principle has been adopted of attempting only to describe specimens of material, machinery, and processes of manufacture which differ substantially from the experience of the United States; thus presenting, as far as practicable, a purely *differential* report upon the iron and steel of the Exposition. The necessity for this course will be apparent from the mere statement that the catalogue of class forty includes 2,395 entries, of which the far larger portion are produced in the United States of equal quality, and by processes equally economical. The exhibition of the United States, however, was of so meagre a character that foreigners, judging from the lessons of the Exposition, would have come to the inevitable conclusion that the iron and steel industry of the United States is not entitled to the rank which it undoubtedly occupies in the metallic production of the world. The various ores mainly used in the manufacture of iron in the United States were indeed to be found among the minerals exhibited from the primitive regions of Lake Superior, New York, and New Jersey, while the brown hematites of Connecticut, Pennsylvania, and Alabama, together with the red fossiliferous ore of Tennessee and Alabama, and a brochure published by Mr. Haines, agent of the State of Alabama, were sufficient to call atten-

tion to the unequalled resources of the United States for the foundation of an iron industry which, under equal conditions as to the price of labor, would soon be in advance of that of any other nation whatsoever. A single piece of spathic ore, from Connecticut, and a few pieces of franklinite, from New Jersey, alone served to indicate the possession of the indispensable material upon which the production of Bessemer steel, as at present practiced, is based. A few pieces of pig iron from Lake Superior, from Wisconsin, Ohio, and Alabama, and some inconsiderable specimens of wrought iron, made from the Lake Superior and the Alabama pig, were the sole indications of an annual production of more than a million tons of iron. The only proof of the existence of any manufacture of steel in the United States was contained in a case of very beautiful specimens contributed by Park Brothers & Co., of Pittsburg, for which they received a silver medal. There was no evidence in the Exposition of our large and increasing product of bar iron, of the rolled girders—in the manufacture of which we preceded the world—of the cut nails, of which we enjoy almost a monopoly, and of the infinite variety of wrought and cast iron, in the skilful production of which we are not surpassed by the most advanced nations of Europe. On the other hand, there was a marked superiority in the products of the European makers designed for uses requiring difficult shapes—a requirement met in our country either by welding or riveting pieces together, and which in Europe, at the present time, seems to be almost universally supplied by material of such admirable quality as to admit of being forged or pressed into the most intricate and unusual forms. Such articles as deeply-dished boiler heads, steam domes, tube sheets, and even culinary vessels of every form and variety, and many other articles of fancy, designed merely as *tours de force*, such as cocked hats, and series of square domes raised from a flat plate, were exhibited, made from a single piece without weld or joint. Nor was this evidence of peculiar excellence confined to any one country. In France, the works at Le Creusot, Chatillon, and Commentry, and those of Messrs. Petin, Gaudet & Co.; in England, the Bowling and Low Moor Works, and those of the Earl of Dudley; in Prussia, the works of A. Borsig, near Berlin, and of Hoerde; and, in Austria, the imperial works at Neuberg, may be enumerated, among others, as having exhibited material of such remarkable quality as to open an entirely new field for the application of iron and steel.

Again, there was unmistakable evidence in the Exposition of the readiness of the European ironmasters to grapple with difficulties in the way of rolling shapes, from which at present the American maker would shrink. For example, Messrs. Petin, Gaudet & Co. (France) exhibited a rolled beam of the depth of 1 metre, (39⅜ inches,) in length 9.72 metres, (over 32 feet,) and weighing 2½ tons. They also exhibited another beam weighing 2.3 tons, 12 inches in height, and over 106 feet in length. The works of Chattilon and Commentry exhibited a beam 43¼ inches in height,

and with a 12-inch flange, but of very moderate length; but another beam was exhibited, about 100 feet in length, 9 inches high, weighing about fifteen hundred weight. The Burbach (Prussian) works exhibited a rolled beam 47 feet long and 15 inches in height. A careful observation, however, of the various structures in process of erection on the Continent, failed to show that these remarkable specimens of rolling had yet been brought within such limits of cost as to admit of their use in building. In the Exposition building itself, no rolled beams were to be found of a greater depth than 9 inches, and in the innumerable buildings which are being erected in Paris, and in which iron beams are invariably employed to the exclusion of wood, 4 inches, 6 inches, and 7 inches are the dimensions most generally employed. Thus far the construction of a fire-proof building in the United States is accomplished with less pounds of iron for a given strain per square foot than in France, and we have nothing to learn from the Exposition in this respect. But now that it has been found possible to produce beams of such large dimensions by the simple process of rolling, it is but reasonable to expect that the cost will be reduced as experience is gained, and that they will gradually replace the riveted girders, which even in the palace of the Louvre are invariably employed for spans of any considerable extent. It is proper, however, to call the attention of our American makers of rolled beams to the extraordinary specimens which we have described, and which it is understood are produced by the aid of the "universal rolling mill." Of this two forms were on exhibition, one in the pavilion of Chatillon (France) and the other in the Austrian department. The latter consists of four rolls, in two pairs, working at right angles to each other, a description of which, illustrated by engravings, can be found in Colburn's Journal (Engineering) for May 24, 1867. Of the mill at Petin, Gaudet & Co.'s no model was exhibited, and no description of it was given in the documents furnished to the commission.

By a personal visit to the works, however, the construction of the mill was seen to be very simple, and not remarkable for novelty. For each size of beam there is a pair of rolls, each having a working face at the middle of its length equal in width to the depth of the beam. The diameter of the roll at this part is very large, say 3 feet 6 inches, the body of the roll for the rest of its length being about 22 inches diameter. This formation of the rolls leaves a considerable space between the two, except where the working faces come together. In this open space is placed a pair of rollers, working on vertical axes fixed in stout movable frames, by which they can be brought into juxtaposition with that portion of the horizontal rolls which is of largest diameter. The pile used is somewhat thinner than the width of the flange to be produced, and of a width somewhat greater than the depth of the beam, and is so made up as to conform roughly to the final shape of the girder. As the main rolls are brought together, and form the trough in the beam, the friction rollers at the sides are also pressed towards the centre, and tend, by the pres-

sure which they exert, to extend the flanges at the same time that the web is being drawn out by the main rolls. An offset is turned in the side of the large portion of the rolls to receive and form properly the flange as it is extended by the pressure of the friction rolls. The latter are worked each by a screw in a horizontal frame bolted to the side of the housing, the screw being provided with a ratchet lever, to be worked by hand. This enables the thickness of the flanges to be adjusted with precision. With this mill they have rolled girders of 40 inches height, 33 feet long, and feel confident that they could make them 90 feet in length. The essential features of this mill were all to be found in the first train for rolling beams, erected in 1853 at the Trenton Works, New Jersey, but in that case the axes of the driven rolls and of the friction rolls were at right angles to the mill of Petin, Gaudet & Co., which is probably a better working arrangement than the old train at Trenton. The Universal mill is not yet introduced into England, but forms the subject of an English patent now expired, and is undoubtedly destined to fill a very important place in the rolling of iron, and the American ironmaster cannot too soon avail of its advantages before impediments shall be put in its way by the issue of American patents.

Next to rolled girders, or perhaps even more remarkable than these, were the specimens of plate iron contributed from England, France, Germany, and Belgium. John Brown & Co., of Sheffield, exhibited a plate which, after being dressed up to square edges and ends, was 30 feet in length, 2 feet 6 inches in width, and 6 inches thick, weighing 11 tons 5 hundred-weight; and also a piece of a plate which in its original condition was 13 feet long, 6 feet wide, 13½ inches thick, and weighed 20 tons.

For the production of these enormous masses of iron the machinery is of the ordinary kind in construction, but of dimensions proportionate to the mass of iron to be handled. The size of the rolls is 3 feet, and the handling of the iron is accomplished with facility by the aid of steam cranes and of iron chains winding upon the rolls themselves, which are reversible by a clutch gearing, and make about 20 revolutions per minute.

Other plates of six inches in thickness and of various weights up to five tons were exhibited by the works of Chatillon and of Messrs. Petin, Gaudet & Co., (France,) and of Hoerde, (Prussia.)

Generally there may be said to exist a prevailing willingness and practice in the European works to handle iron in larger masses for every purpose than we do in the United States. For example, Belgium exhibited band iron three-fourths inches wide by 230 feet in length; Prussia exhibited sheet iron of 21½ gauge, 48 by 108 inches, and wire rods are frequently to be found in all the departments ranging from 30 to 50 pounds in weight, rolled in trains of the ordinary dimensions, and running at speeds no greater than we employ in the United States, for 15 pound billets. This is accomplished by keeping the billet in many more grooves at the same time than we are in the habit of doing, by an ingenious system of doubling the rods backwards and forwards. This same

method is employed at Montataire, in France, and at other works for rolling braziers' rods, and even bar iron; and this not from the necessities of the order, but from choice, as a matter of economy. In this way one-inch bars of 100 feet in length are regularly produced, and this system, unknown in the United States, can doubtless be introduced with great advantage.

But the most remarkable specimen of rolling was in the English department, exhibited by Richard Johnson & Nephew, of Manchester, in the shape of a coil of No. 3 wire rods, weighing 281 pounds, in length 530 yards, rolled from a single billet. Also a coil of No. 8 wire weighing 200 pounds, 900 yards in length, and a coil of No. 11 wire weighing 95 pounds, in length 790 yards. These wonderful specimens of wire were not, however, produced in an ordinary mill, but were rolled in a machine invented by George Bedson, the manager of the Bradford iron works, in Manchester. This machine consists of rolls in thirteen pairs, placed one behind the other, instead of side by side, as usual, with guides connecting the successive pairs of rolls, and revolving at such relative rates of speed, that the billet being rolled receives the compressing action of the rolls all at the same time. The billet is fed from a long heating furnace at one end of the train of rolls, being charged at the end of the furnace furthest from the train. A Siemens' generator is used to supply the furnace with gas, so as to insure a uniform heat. The average product of the train is 11 tons per day, and the weight of the billets usually rolled is from 80 to 100 pounds. A comparison of the work for six months, with two old-fashioned trains also running in the same works, shows that the waste is reduced from 10½per cent. to $6\frac{9}{10}$ per cent., and that the consumption of coal is reduced from 14 hundred-weight, three quarters, 25 pounds, to 8 hundred weight, and 18 pounds per ton, most of which saving is doubtless due to the use of Siemens' furnace, and not to the train; the advantages of the latter consisting in an increase of product of nearly one-half in the increased weight of the billets rolled, and in the economy of the labor employed. A personal visit was made to the Bradford iron works, to see the operation of this ingenious and successful machine. It appears to be all that could be desired, and the action of the rolls upon the iron unquestionably produces a sounder and better rod than when worked by the old process, and this is due doubtless to the higher and more uniform heat at which the rod is finished.[1]

In the use of wire for telegraphic purposes, for wire suspension bridges, and for cables and ropes, the superior value of long lengths is undeniable. Bedson's machine has therefore the double merit of producing a better article, at a lower cost, than has hitherto been obtained; and it is a matter of regret to those who have become familiar with its novelty and its merits, that it received only the recognition of a silver medal, when it so justly deserved the highest prize.

---

[1] The same principle has been since successfully applied to the rolling of bar iron.

Borsig, of Berlin, exhibited remarkable specimens of gigantic puddle balls, a single one weighing 1,064 kilograms, (more than a ton,) and he also exhibited a wrought-iron piston without a weld, weighing 590 kilograms, (nearly 12 hundred-weight.) These are not mere *tours de force*, as he is prepared to take orders at a price which renders it economical to employ his product.

In connection with the large masses of iron with which, as demonstrated in the Exposition, modern industry so much occupies itself, it is proper to refer to the crank shafts exhibited by Messrs. Marrel frères, of Gier, (France.) Of these one has three cranks placed 120° apart, and has a length of nearly 40 feet, the weight being 30,180 kilograms, or about 30 tons. Another is a four throw crank, say 27 feet in length and 12 inches in diameter.

Among the new applications of iron exhibited in the Exposition are the weldless bands made at the Bowling and Low Moor works,[1] (England,) employed for uniting the cylindrical sections of steam boilers, covering the joints and strongly riveted on each side thereof, so not merely as to make a firm union, but greatly to stiffen the boiler when finished. The Bowling ring has a cross section like the letter U, with wide flanges, and seems better adapted to stiffen the boiler or flue, and to allow of expansion and contraction, than the flat ring made by the Low Moor works.

The one on exhibition is seven inches in total width, three-eighths thick, the arch in the middle rises two inches, and the width of the flanges is two and one-half inches. These bands would appear to be thoroughly well adapted to their purpose, and worthy of immediate adoption in our country.

CAST STEEL.

In cast steel, by whatsoever process produced, the same tending to large masses and difficult shapes was to be remarked. In advance of all other makers, the specimens exhibited by Krupp, of Essen, (Prussia,) were worthy of the highest admiration. The largest single piece of cast stell was a cylindrical ingot forged at one end into an octagonal shape, 56 inches in diameter, and weighing 40 tons. The grain of this ingot was exposed by the fracture of the forged end, and was uncommonly uniform and free from air bubbles. A piece had also been cut from the portion not forged, which showed at the place of fracture an equally uniform grain.

At the English exhibition of 1851, a cast steel ingot exhibited by Krupp, weighing two and a quarter tons, caused more astonishment than the ingot we have just described, because the world has since become familiar with metallic masses of enormous size, but the progress made in sixteen years in the production of cast steel is none the less marvellous, especially if considered in connection with the machinery necessary to produce and

[1] For a description of the process of making iron at Low Moor, Bowling, and Farnley, the reader is referred to "Percy's Metallurgy of Iron and Steel," page 732.

work the ponderous ingots into shape, and the organization of the labor and skill required for their formation.

The establishment of Krupp occupies about 450 acres, of which one-fourth are under roof. The number of men employed in the works is 8,000, besides which 2,000 more are employed in the coal mines, at the blast furnaces, and at the ore mines. The production of these works in 1866 was 61,000 tons, more than the entire production of cast steel in the world at the time of the first English exhibition. The value of this product was over $10,000,000 in currency. It was accomplished by means of 412 smelting, reverberatory, and cementing furnaces, 195 steam engines, ranging from 2 to 1,000 horse-power, 49 steam hammers, in the largest of which the hammer block weighs 50 tons,[1] 110 smiths' forges, 318 lathes, 111 planing machines, 61 cutting and shaping machines, 75 grinding machines, 26 special tools. 1,000 tons of coal are consumed daily in the manufacture of steel alone, and 120 steam boilers are in use evaporating 150,000 cubic feet of water daily. Fifteen miles of rail are laid in the works alone, and 6 locomotives and 150 cars are required for its use within the limits of the establishment.

In order to appreciate the eminent justice with which the grand prize of the Exposition was bestowed upon Frederick Krupp, it is not merely necessary to study these marvellous figures, but to consider that this establishment, by far the most extensive ever produced by the energy of man, and these processes, the most difficult ever attempted by his ingenuity, are the offspring of a single life, begun almost by the side of his father's humble forge, and rising through the various stages of poverty, trial, discouragement, and final success, to the very front of the industrial achievements of the world. Such an establishment, such results, and such a man, have special interest for the United States, where the natural resources of the country, the rapid progress of population and civilization, and the genius of our free institutions, all invite a generous emulation in order to equal, and in course of time even to surpass these magnificent achievements, which, if Krupp, the great captain of modern industry, had not lived in our day and generation, might well have been deemed impossible.

Among the other remarkable specimens exhibited by Krupp is a cast steel tire, rolled without weld, eight feet in diameter, a cast steel axle of crucible steel, with cast steel disk wheels, neither forged nor rolled, but cast directly into shape, weighing 1,623 pounds; a cast steel locomotive crank axle, with cast steel wheels six feet in diameter, weighing 3 tons 13 hundred weight; a cast steel junction ring of angular section, for uniting the courses of steam boilers, made without weld, eight feet in diameter, weighing 483 pounds; a cast steel double crank shaft for a screw steamer, 25 feet long, 14 inches in diameter, weighing (finished) 9¼ tons; forged under the 50-ton hammer from an ingot originally weighing 27 tons. And this is a proper place to note that cast steel crank shafts appear to

[1] Krupp is now erecting a hammer of 120 tons.

be coming into general use, not merely for locomotive and stationary engines, but for the massive marine engines which are required for the steamers devoted to the business of transatlantic navigation. The experience with these cast steel crank shafts for marine engines does not appear to be sufficiently extensive to warrant any positive opinion as to the comparative value of cast steel and iron for the purpose, and it is possible that in cases where great resistance to torsion is required, iron will maintain its place. In any event the attention of engineers has been so called to this subject by the Exposition, that we may expect soon to have all doubts on this important subject removed.

The most striking object, however, in Krupp's exhibition, was the cast-steel 1000-pounder rifled breech-loading gun, resting on a cast-steel carriage intended for the arming of coast batteries for the destruction of iron-plated ships. It consists of an inner tube, upon which are shrunk cast-steel rings. This tube was forged under the 50-ton hammer, from an ingot weighing 40¼ tons, but reduced in the process of manufacture to 20 tons by the loss of the sinking head, and by forging, turning, and boring. The cast-steel rings are three in number at the powder chamber, and two in number towards the muzzle portion of the gun. These rings weigh 30 tons in the aggregate, and were each manufactured from an ingot without welding. The total weight of the gun is 50 tons, the diameter of the bore is 14 inches, and the total length of the gun is 210 inches. In has 40 rifle grooves, in depth .15 inch, and the twist of the rifling diminishes from one turn in 980 inches to one turn in 1,014.4 inches; the weight of the solid shot is 1,212 pounds, and of the shell 1,080 pounds, and the weight of the latter is made up of the cast-steel shell, 834 pounds, the lead jacket, 220 pounds, and the bursting charge, 17 pounds; the charge of powder for the gun is from 110 to 130 pounds. The cannon reposes upon a steel carriage weighing 15 tons, and the two together work upon a turn-table weighing 25 tons. The turn-table was not exhibited for want of space, but it was stated that the gun-carriage slides smoothly upon the turn-table to the cheeks at the backstays at each discharge of the gun, and that two men can quickly and easily elevate, depress, and turn the gun so as to follow and cover with speed and certainty any vessel in motion. The price of the gun, which is understood to have been made for the Russian government, is £15,750 sterling, and of the carriage and turn-table £6,000, being about $150,000 in currency. Sixteen months of unremitted labor, by day and night, were expended upon its manufacture, and its transportation from the works to the Exposition required a car made entirely of steel and iron, weighing 24 tons, resting on 12 wheels.

It forms no part of the purpose of this report to institute a comparison between different systems of ordnance, or even to undertake to decide the relative value of cast and wrought iron and steel for the manufacture of guns, but it has been deemed best to give a somewhat elaborate description of this monster engine of war, in order to indicate the possi-

bilities of construction in its most difficult and expensive form, in case experience should show that such weapons will hereafter be required in our own country. In this connection a comparison with the largest guns produced in England will be of interest. Sir William Armstrong exhibits a 12½-ton 9-inch muzzle-loading rifled gun, constructed on the coil principle, and mounted on a wrought-iron carriage and slide; the weight of the projectile is 250 pounds, and the charge of powder 43 pounds. This gun is beautifully made, and is noteworthy from the fact that the compression for checking the recoil is wholly of iron, and is thrown in and out of action by a lever-handle, which is self-acting if neglected. The gun is designed for use on shipboard. The largest Whitworth gun exhibited is a 150-pounder, and is constructed exclusively of mild steel, wrought into tubes, which are forced into each other by hydraulic pressure. But to us the most interesting gun is the 9-inch Paliser gun, made by casting an exterior coating of iron around an interior barrel of wrought iron, constructed on the coil principle. This gun carries a projectile of 250 pounds, and if in practice it should be found to have substantial advantages over our cast-iron guns, it suggests a method by which we may apply the principle to the reconstruction of the large number of cast-iron guns which have been accumulated during the last few years. The gun now manufactured by the British war department, at Woolwich, consists of a cast-steel tube, upon which rings of fibrous wrought iron, made upon the coil principle, are built up, and the specimen exhibited was a 12-inch muzzle-loader, weighing 470 hundred-weight, length of bore 145 inches, having 9 grooves, each 1½ inch wide and .2 inch in depth, the spiral increasing from one turn in 1,200 to one turn in 600. The weight of the charge of powder is 70 pounds, and of the projectile 600 pounds.

The only other gun requiring notice was a cast-steel gun, made by Petin, Gaudet & Co., weighing sixteen tons, and intended to throw a projectile of 300 pounds in weight; but it was quite evident that the manufacture of steel and wrought-iron guns in France is still in its infancy, and there would seem to be the same uncertainty in regard to their value as prevails in the United States. But there would seem to be no doubt that within certain limits of size, and perhaps for all sizes of field-pieces, cast steel is regarded as the best material, and Krupp has already produced more than 3,500 cast-steel guns, mostly rifled breech-loaders, and at the present time has orders in hand for immediate delivery of 2,200 guns, ranging from 4-pounders to 300-pounders. Not much accurate information is to be procured in regard to the endurance of the larger sized guns, but Krupp exhibited a cast-steel rifled 4-pounder breech-loading gun, belonging to the Prussian war department, which had been fired several hundred times, with gradually increasing charges up to three and three-quarters pounds of powder and 122 pounds of shot, without the slightest appearance of injury.

Although no evidence was afforded by the Exposition of the substitu-

tion of cast-steel for cast-iron shot in the French service, my visits to the French iron works seemed to show conclusively that such is the case, as all the large establishments were actively engaged in the manufacture of cast-steel missiles of all sizes, but more especially of the larger calibre; and whatever the fact may be, it is quite evident that cast steel is regarded by French military engineers as superior to all other materials where penetration is required.

Krupp also exhibited a cast-steel rail 50 feet in length, and bent double, cold, in the middle, without fracture. His engineer in the Exposition stated that their annual product of rails was about 30,000 tons, and that no Bessemer steel was employed in their construction. In the absence of a personal visit to the works, we are bound to accept this statement as true, although it is stated on good authority that as many as nine pairs of converters are constantly employed at the works in the production of Bessemer steel, and there seems to be an impression that the tires latterly produced at Essen are not quite equal in quality to the remarkable material which was at first employed for this purpose. This may be only the result of rival representations, and it is undeniable that up to the present time Krupp maintains his pre-eminence in the manufacture of locomotive tires, and is probably justified in the claim which he makes, that his crucible cast-steel coils are superior to those made from Bessemer metal. In the year 1865 the sale of cast-steel tires amounted to 11,396 sets, and the guarantee of their endurance given by Krupp is that they will run 400 kilometres for each kilogram of weight, (equivalent to 125 miles per pound;) that is to say, a tire weighing 600 pounds is guaranteed to run 75,000 miles, but their actual performance as a general rule shows a much higher endurance. The results with these tires and those of other makers—such as Naylor, Vickers & Co., Firth & Sons, the Bochum Company, Petin, Gaudet & Co., the Bowling Company, and the Monk Bridge Company, and other respectable makers, would seem to justify the broad statement that the day for iron locomotive tires has passed by, and that it is far more economical, if not more safe, to substitute cast-steel tires in every case.

The same conclusion cannot yet be affirmed of rails, because the interest account, of but little consequence in the case of the tire, becomes a very serious and indeed controlling element in the case of rails. It may be stated, however, that in all cases where iron rails wear out in consequence of hard service within the limits of duration assigned to a steel tire, it is quite as economical to use steel rails in lieu of iron ones as it is to use steel in lieu of iron tires. But, assuming the cost of cast-steel rails to be double that of good iron rails, it is quite evident that there must be a limit in the duration of iron rails beyond which it will not pay to substitute cast steel. This calculation is one which must be made by each consumer for himself, with reference to the available capital at his disposal; but it is safe to declare that on all roads where the iron rail has an average life of ten years it would not be profitable to

substitute cast-steel rails, and so long as the average rate of interest paid by railroad companies in the United States amounts to eight per cent. per annum it would be found expedient considerably to reduce the limit of ten years above assumed for the duration of iron rails before the substitution of steel rails could be justified on grounds of economy. Even in England, where capital is superabundant and the rate of interest on long obligations not over five per cent., and the traffic per mile of very large dimensions, requiring, as a general rule, the renewal of iron rails in seven years, cast-steel rails have thus far not been very extensively introduced; and even on the London and Northwestern railway, which owns a mill devoted expressly to their manufacture from Bessemer steel, and which, from its enormous traffic, has every inducement to make its road as permanent as possible, the money question seems to check the use of cast-steel rails upon any very extended scale. And yet the necessity of more durable rails than those generally in use is so apparent that any attempt to secure greater durability without much additional cost is regarded with great interest, and hence in the Exposition there were many specimens, and from all the leading nations, of *iron* rails with *steel* heads. In some cases the material employed for the head was puddled steel, in others cast steel, and in others Bessemer steel. It seemed to be generally admitted that the durability of the steel in the head was in nowise impaired by its being placed upon a cushion or bed of wrought iron, but the great difficulty appeared to be in securing a thorough union or weld between the two kinds of metal. In the Austrian department, where some admirable specimens of steel-headed rails were exhibited, from the Neuburg Works, the engineer in charge stated that nine per cent. of the heads failed in the weld during the first year, but that subsequently no failures occurred, and that even with this amount of loss the rails were regarded as cheaper than either steel or iron. At Crewe, where the works of the London and Northwestern Company are situated, and where a considerable quantity of Bessemer steel-headed rails have been made, it was stated that some difficulty had been found at first in making a reliable weld of the steel to the wrought iron, and that as many as five per cent. of the rails first made had failed in consequence of the loosening of the steel top; but as experience was acquired in the manufacture this difficulty had disappeared, and the percentage of loss had been reduced materially. The practice at Crewe is to place a bar of soft puddled iron between the steel of the top and the old rails used in the lower part of the rail, and as a further protection the steel for the head is rolled in the form of a channel bar, with ribs in the recessed portion so as to fold around and embrace, as it were, the head of the rail. Considerable experience has already been acquired in the United States as to the feasibility of making a sufficiently good junction between the iron and steel for a durable rail, and it may be confidently affirmed that there is no practical difficulty in the way of making an iron rail with a steel head, whether of puddled, Bessemer or cast metal, that will meet all the reasonable requirements

of the case, and reduce the failures to less than one per cent. The cost of steel-headed rails is, of course, intermediate between that of all iron and that of all steel rails, and the system possesses the great advantage of rendering all the old rails available for re-manufacture, and of thus renewing the tracks with a bearing surface of steel by gradual steps, and with a very moderate increase of cost. On the London and Northwestern railway, which has had the most experience in the use of Bessemer and steel-headed rails, experience seems to show that the steel-headed rails possess all the requirements in point of cost and durability for their general introduction on the line, and the conclusion is irresistible in my own mind, after a careful study of the specimens in the Exposition, that the steel-headed rail will ultimately prevail over all other kinds of rails now known, and that in the United States the facilities for their manufacture are unusually favorable. It is a question in what manner the steel shall be made for the heads, and this point will be discussed when we come to speak of processes, and it is enough to state here that a good steel head can be made from any one of the kinds of steel above specified.[1]

In closing this brief statement of the remarkable specimens of cast steel in the Exposition, the products of the Bochum Company (Prussia) should not be overlooked. An enormous cast-steel bell, weighing 29,500 pounds, remarkable for the admirable proportion which existed between its size and its tone, was not, however, more wonderful than the cast-steel railway wheels made in sets of ten or a dozen, united by a thin shaft of metal running through the centres, thus enabling one sinking head to answer for the whole quantity, and securing greater density and soundness in the metal. These wheels, when cut apart and turned up, were beautifully sound and clean, and gave evidence of ability to cast steel with as much facility as ordinary cast iron. Another evidence of this was to be found in a locomotive cylinder, bored and of such finish and soundness as not merely to excite general admiration, but induced the belief that possibly it was cast iron which had been deprived of its carbon by being annealed in a bath of oxide of iron, or some other decarbonizing material.

In the Swiss department, machine-cut steel files were exhibited fully equal to any cut by hand; and this result is said to be due to the grinding of the blanks across the face instead of lengthwise, a point which may have great value to our own makers of files.

QUALITY OF MATERIAL.

A careful observer of the iron and steel specimens in the Exposition could not fail to be struck with the varieties in the quality of the metal exhibited and the evident attention paid to the adaptation of special

[1] In view of the great interest which this country has in securing good rails, I have obtained permission to insert in an appendix (F) a very valuable paper, recently read before the British Association of Civil Engineers, by C. P. Sandberg, esq., inspector of railway material for the Swedish government.

qualities to special uses. In some establishments only a particular quality would be produced, but, as a general rule, all the large works exhibited, and seemed prepared to produce, a quality proportioned to the price to be paid.

In the pavillion of Le Creusot, for example, seven different qualities of merchant iron were displayed as examples of the uses to which each quality would be applied, and a personal visit to the works satisfied me that there was nothing fanciful in these grades. In the Welsh iron works it is notorious that the quality of the article produced is directly proportioned to the price paid for it, and in my visits to those gigantic establishments which have grown up in the mountains of South Wales, it was humiliating to find that the vilest trash which could be dignified by the name of iron went universally by the name of the American rail.

This is no fault of the Welsh iron-master, but has arisen from the almost universal practice of late years, on the part of American railroad companies and contractors, of purchasing the lowest-priced article that could be produced. Of course no iron of this quality was to be found in the exposition; but if prizes were to be given for mere human ingenuity, I cannot conceive of anything more entitled to it than the production of a well-finished rail from puddled balls, that will not hold together under the alligator squeezer.

There is, however, one thing more remarkable even than this low quality of iron; and that is, the stupidity and reckless extravagance of the customers who are found to buy it. To this cause, more than any other, is due the necessity of almost annual renewals of rails in the United States, and of the financial troubles of so many of our leading lines of railway; nor is there the slightest excuse for this result, for the Welsh iron-masters, to their credit be it said, make no concealment either of the inferiority of the material, or the poverty of the process by which it is treated, and greatly prefer to turn out work creditable to themselves, and profitable to their customers. But the inexorable law of competition, and the unremitted cry for cheap iron in America, have left them no choice.

For their own country, for the continent of Europe, and for India, no such system is practiced. As a general rule, all rails made for home consumption are guaranteed for from five to seven years, according to the traffic; that is to say, every rail that fails in the slightest degree within the time specified is renewed at the expense of the maker. The extra price paid for a guaranteed rail on roads of moderate traffic is about 30 per cent., but on roads having a heavy traffic at least 50 per cent. additional is paid. In cases where the guarantee cannot be procured in consequence of the heavy usage to which the line, or any portion of it, is subjected, the conclusion is inevitable that a steel rail should be used. And until a similar system of guarantee and adequate payment therefor is introduced into the United States, shareholders in railway companies can place no reliance on the security of their investment and the permanency of dividends.

It is this difference in the quality of iron, and its corresponding money value, which enables particular works and special regions to thrive under local disadvantages as to cost. To some extent the same rule applies in the United States, but it may be affirmed that there is no civilized country in which the discrimination is made to so small an extent, and which loses so much by its indifference.

A very remarkable proof of the adoption of particular quantities to particular purposes is to be found in Sweden, which possesses inexhaustible stores of primitive ores, many of them adapted to the manufacture of steel and the very highest grades of bar iron, and yet, for some purposes, ores which contain phosphorus are absolutely preferred to the purer ores, even through procurable at the same price. For tools, such as spades, shovels, hoes, and other utensils, and for roofing-sheets, which are to be subjected to severe wear, at least one-tenth of one per cent. of phosphorus in the iron is considered desirable.

Again, in France, in order to produce the better grades of iron, ores are brought in large quantities from Elba and Algiers, at a high cost, which is reimbursed by the purchaser.

If there was any lesson clearly taught in the Exposition, it was the willingness of the public to pay an adequate price for skill and quality, and this willingness must spring from an enlightened self-interest.

There is no difficulty whatever in producing in the United States any quality of iron and steel that may be desired, for we have an exhaustless profusion of the best kind of ore and coal, and, at the present day, so open to communication as to render them available with as little expenditure of human labor as in the most favored countries of Europe. But the problem presented for solution to the American iron-master has not merely been to procure this labor at as low a cost as it is obtained in Europe, (a requirement utterly impossible to be met,) but to produce the highest grade of material in competition with the price of the poorest foreign article. For the difference in the price of labor a remedy may be found in the tariff, but for the other exaction there is no remedy but greater intelligence on the part of the consumers, and in all cases where life or limb is at risk, the enforcement of the law as to the responsibility for the use of inferior material.

PROCESSES OF MANUFACTURE.

Having completed a brief survey of the articles in the Exposition which to the eye of an American would appear remarkable, we come next to the consideration of the processes employed in the manufacture of iron and steel which have not yet been introduced, to any considerable extent, in the United States. And first, in the natural order, comes the production of wrought iron and steel by a direct process from the ore. To some extent this branch of industry still continues in the United States, especially in the northern part of the States of New York and New Jersey, where the process employed is usually but incorrectly

known as the Catalan method of making wrought iron. But in Europe this mode of making iron may be said to have died out, although in the mountains of Spain, and some portions of Italy, a few fires still maintain a feeble existence. The practial mind of Europe and America, however, has never ceased its efforts to produce wrought iron and steel directly from the ore, by some convenient and economical process, and perhaps at no time has this subject received more attention than at the present. Of this interest, however, the Exposition afforded but a single example, but that example in a quarter so distinguished both for scientific and mechanical knowledge, and for success so eminent in another direction as to have merited the grand prize of the Exposition, that it seems reasonable to expect the solution of this difficult problem, if it be at all possible, at the hands of Charles William Siemens, whose regenerating furnace will be the subject of subsequent consideration. In the exhibition of Mr. Siemens were some small specimens of cast steel, which had been made direct from the ore, but which would scarcely have been remarked but for the eminence of the maker. They were made in conformity to a patent issued to Mr. Siemens on the 20th September, 1866, in which he states that his invention has for its object the production of iron or steel directly from the ore, and in a continuous manner, analogous in this respect to the continuous action of the blast furnace; and consists in exposing a mass of ore, which may or may not be mixed with reducing agents or fluxes, upon an inclined surface, to the surface action of intense heat, and in introducing at the same time a current or currents of combustible gases or petroleum oil in among the mass from below the inclined surface, so as to percolate through the mass of ore, affecting or aiding in its reduction, and at the same time enveloping its surface where exposed to the flame in a deoxidizing or reducing atmosphere, tending to facilitate its fusion. The fused metal and cinders accumulating at the foot of the inclined surface are from time to time removed, while a mass of ore is maintained upon the inclined plane by its own gravitation, fresh ore being supplied from hoppers at the top of the incline in regular quantities. The intense heat spoken of in this description as necessary for the process is produced by Siemens' regenerative gas furnaces. Mr. Siemens has been conducting experiments upon the red hematite ores at Barrow in Furness, with a view to demonstrate the practicability and economy of this process, but it is yet premature to estimate the measure of his success. If, however, he should succeed in practice, with the magnetic ores of the Atlantic highland range stretching from New York to Georgia, and the primitive peroxides extending from the great lakes through Missouri and Arkansas, with the command of the fuel and the petroleum indispensable for its success, this process will be of incalculable value to the United States.

In the preparation of ore for the blast furnace, Sweden exhibits the model of a roasting furnace invented by Mr. E. Westman, and which was adopted in the first place at Dannemora works, and since generally intro-

duced at the other iron works in Sweden. It consists of a vertical furnace which is heated by a portion of the gas drawn from the blast furnaces themselves, and introduced at the bottom of the roasting furnace through suitable flues by the aid of natural draught. The temperature in the furnace is carried to such a degree as to soften the ore, and drive off the sulphuric acid arising from the oxidation of a portion of the sulphur, disengaged by a distillation of a lower temperature from the pyrites, which may be mixed with the ore; a portion, moreover, of the sulphur is oxidized by the oxygen of the ore. Ore thus roasted, however dense when charged into the roasting furnace, is discharged at the bottom quite porous, like a sponge, and almost entirely free from sulphur, if it do not contain more than four per cent. in its natural state. With ore so roasted, and which presents an entirely different appearance from ore prepared in a common kiln, the statement is not surprising that the blast furnace runs with far greater regularity and with much less consumption of fuel. The introduction of this roasting furnace will be of great value when magnetic ores are smelted with charcoal. It is highly probable that even in furnaces fed by mineral coal, it will bring into economic use a great variety of ore now rejected on account of sulphur. So important did this furnace appear, that the undersigned at once engaged a Swedish engineer to proceed to America, where he is now erecting a furnace at Ringwood, in New Jersey, so that at an early date it may be examined by the public.

Besides economizing coal, the Westman furnace, in connection with other improvements resulting from a more accurate knowledge of the theory of the blast furnace, and a careful study of its operation, has greatly increased the weekly product of the charcoal furnaces in Sweden. The general dimensions of the blast furnaces are from eight to nine feet across the boshes, and from forty to fifty feet in height. The average product of these furnaces driven with a blast heated to 150° to 200° Centigrade is about seventy-five tons per week, which is nearly double the product made a few years since, and now made in the United States from the same class of magnetic ores, which must be carefully distinguished from the brown hematites of Connecticut and the peroxides of Lake Superior. The charging of the furnace, in particular, is most carefully attended to; absolute uniformity in the size of the pieces of ore is insisted upon, and the charge is distributed over the furnace by a shovel, in which it is first weighed, and then run on a suspended railway to the tunnel head of the furnace, which is never closed. The most intelligent engineers expressed the opinion that the furnaces would give better results if made larger; but as they are, 100 pounds of cast iron are produced with ninety pounds of charcoal, which is as near as possible at the rate of 112 bushels to the ton. To supply this quanity of coal it is estimated that 5,000 square metres (about 6,000 square yards) of wood land are required, and the most vigorous care is practiced in order to insure a perpetual supply of wood to the works. This is not in consequence of any regulation of the government, as is generally supposed, but by a concurrence of action among

the Swedish iron-masters, who have an association administered with great vigor and intelligence. For the production of 100 pounds of bar iron from the pig 100 pounds of charcoal are required where the works are upon a scale sufficiently large to work to the best advantage.

The English run-out or refinery fire is not in use in Sweden, but the refining is all accomplished in the ordinary forge fire generally in use in Pennsylvania. Various modes of treatment in this fire are employed, but the one most generally used is the Lancashire method, substantially the same as the Welsh process generally employed in the United States. At Dannemora the Walloon method is employed, and at Elfsborg the method of Franche Comté is in use. At Kihlafors a combination of the Walloon and Lancashire methods is adopted, which is said to produce a very superior quality of iron with a very small consumption of coal. A detailed description of these methods may be found in Percy's Treatise on the Metallurgy of Iron and Steel, pp. 591, 604. They all give good iron if they are properly followed.

The special interest which these Swedish irons have for us consists in the fact that at this day, as for many years past, they are regarded as indispensable for the production of the best quality of cast steel by the crucible process. Hence the exhibition made by Sweden was among the most interesting in the Exposition, and it is creditable to that country and its iron-masters that it was not only most complete in all its details, but afforded an opportunity of studying its peculiar process of manufacture, from the ore to its final result in the highest grade of cast steel. The Swedish exhibition was in charge of a most intelligent engineer, Mr. L. Rinman, who took the greatest possible pains to furnish whatever information might be desired in regard to the manufacture of metals in Sweden.

The Dannemora irons have generally a fine grain, but unequal in size, composed apparently of hard and soft particles, but in ductility and tenacity the strength of this iron still maintains its superiority over all others; and it has the remarkable peculiarity that, when heated, it becomes very soft and full of fibre, and when cemented and cast into steel the inequalities of fracture entirely disappear. The irons made by the Lancashire fires are generally the most equal in grain, and this is supposed to be due not so much to the primary process of manufacture as to the peculiar mode of reheating and hammering to which they are subsequently subjected. For reheating, the gas welding furnace, as it is called, is usually employed, by which the bloom is subjected to so high a heat as to become incandescent, so that when subjected to the hammer all raw iron breaks in pieces, and is thrown off in the forms of small bits and blue sparks. Loops which act in this way are absolutely rejected for commercial purposes, and are only used for the local wants of the works themselves. There can be no doubt in my mind that to the use of the gas welding furnace, and the high heat, coupled with care in the selection of ores, is due the superiority which must be accorded to

Swedish over American iron made by the charcoal process. For steel, iron ore containing phosphorus is absolutely rejected, and it is a curious fact that Mr. Le Play, so long ago as 1846, prepared a table of Swedish iron, arranging their rank according to the price which they bore in the steel market of Sheffield, and the subsequent analysis of these irons shows that this value, determined by the practical experience of the manufacturers of steel, is directly determined by the quantity of phosphorus and sulphur contained in the pig iron from which the bars are made.

Inasmuch as the consumption of Swedish iron in the United States is very considerable, and the demand for that quality of metal is likely to increase, to be met either by importation or by domestic production, I have deemed it best to append to this report a copy of the table obligingly furnished by Mr. Rinman, giving the names and marks and kind of ore used in all the Swedish iron works; and also to append an analysis of the different kinds of pig iron from which they are made. A careful study of these two tables (Appendix A) will not only guide the consumer in the selection of the kind of iron which he may require for special purposes, but will enable the American iron-master to select the kinds of ore with which he may hope to replace Swedish iron in our own markets. But let it not be supposed that this last result can be achieved by ore alone. The same care in the manufacture, and the same severe test which is applied to the loops, heated to the highest point, will be required to insure a uniform and satisfactory result. The best form of gas furnance is probably that of G. Ekman, models of which were exhibited in the Exposition, and a description of which can be found in Percy's Metallurgy, page 716.

It is well to note that in the forge, or sinking fires, two tuyeres are generally employed, placed opposite to each other, by which the production is increased and the consumption of coal diminished, and the iron is generally regarded as more homogeneous. Puddling with wood is also practiced to a considerable extent in Sweden; and, in this connection, although somewhat out its proper order, it is best to describe the furnace devised by F. Lundin, of Carlstadt Munkfors, designed for the consumption of turf and peat, without drying, and of wet sawdust or other moist fuel; an invention deemed so valuable that the association of Swedish iron-masters have rewarded Lundin by a gift of $10,000, which, in Sweden, is a very considerable sum. In this furnace the fuel is fed by a hopper into a reservoir, resting upon an inclined grate, supplied from below with air from a blower. The products of combustion thus produced pass through a condenser, where all the moisture in the gas is condensed. The gas then passes to the heating furnace, which is furnished with Siemens' regenerators. It is found easy to use fuel containing as much as forty-five per cent. of water, and the resulting gas contains about thirty-three pounds of water to one hundred pounds of dry gas, and the water, after condensation, contains about two per cent.

of its weight in gas, or three per cent. of its volume. The condensing apparatus consists of 3,500 pounds of iron bars piled crosswise on each other, and kept cold by a jet of water from a tuyere. The heat of the gas before condensation of the water always melts lead easily, and sometimes zinc. The expense of the construction of a full-sized furnace in Sweden is about $2,500 in currency, and it is estimated that such a furnace will utilize 1,700 tons of fuel in a year, at a saving proportioned to the cost of other fuel in the particular locality where it is employed. In Sweden it is estimated that the annual saving, resulting not merely from the cost of the fuel, but from the repairs of the furnace and the increased temperature, amounts to over $5,000 per annum on the product of each furnace. In the Ekman furnace dry wood containing eight per cent. of water produces in the generators gas of a temperature of 1,394°, while in the Lundin furnace the temperature is 2,666°, the combustion in both cases being produced by cold air. The gas produced by seasoned wood contains more water than that which proceeds from the Lundin condenser. The duration of the furnace is simply surprising, and is to be attributed probably to the fact that there is no cinder. In eight weeks the thickness of the roof, 4 inches, was only diminished from ¼ to ⅜ inch, and the side walls were entirely uninjured. So wonderful is the success of this system of condensation, in connection with the Siemens' regenerators, that, in Sweden, and in fact everywhere where moist fuel is employed, the Lundin furnace will supersede every other. Its great merit is, that it is available for any kind of fuel whatever. In the United States it is believed that this arrangement might be employed advantageously for washing the gas obtained from mineral coal; but its chief merit consists in the fact that in mineral regions, far removed from the coal fields, it is possible to establish iron works, using sawdust or peat with entire success and great economy. In the lumber regions of Lake Superior it will be found to have a special value, because there is an abundant supply of pig accessible to the saw-mills on Green Bay and in Michigan, producing enormous quantities of sawdust, slabs, and waste timber.

Although reluctantly I have been compelled to abandon the idea of accompanying this report with drawings, and to rely rather on references to printed publications, the drawings of the Lundin furnance are annexed in Appendix B, not merely because they are not elsewhere attainable, but because the value of the invention is such as to secure its immediate introduction into the United States, in many parts of the country where mineral coal is dear or not attainable.

The Exposition presented very complete specimens of pig iron from all parts of Europe, but the experience valuable to our American iron-masters could only be acquired by actual visits to the works where they were produced. In South Wales the most remarkable feature was the endurance of the furnaces, some of which had been in blast for more than 20 years, and no furnaces were expected to go out of blast under 10 or 12

years. As the production of these furnaces varies from 200 to 300 tons per week, and the ores and coal are not less calculated to wear the lining than our own, it would be very desirable to determine the cause of this greater durability. In Wales the heat of the blast is usually about 600°, and its pressure from three to three and a half pounds per square inch. As all these conditions are to be found at particular works in the United States, where furnaces continue in blast only from three to four years, it would seem that the quality of the bricks might explain the difference. Another peculiarity of South Wales is the great difference in the product of furnaces having the same dimensions and shape and using the same materials, and for which the experience of the iron-masters offered no adequate explanation. Again, at Ebbw Vale, the Sirhowy furnace, 73 feet in height, 18 feet across the boshes, with the hearth seven feet six inches in diameter, and the tunnel head ten feet in diameter, containing 11,900 cubic feet, did not produce as much iron as another furnace seventeen feet six inches across the boshes, forty-eight feet high, with the same sized hearth and top containing 6,590 cubic feet. This latter furnace averaged about 380 tons of iron per week, using about one and a half ton of raw coal to the ton of iron. Its interior section was in the form of two cones meeting at the boshes, and a drawing of it will be found among the Ebbw Vale furnaces, marked E. V., No. 3, p. 559 of Percy's Metallurgy of Iron and Steel. The only mechanical arrangement of these furnaces worthy of special notice is the cup and cone device at the tunnel head, which is described in Percy, page 470, perfected at the Ebbw Vale iron works, and now generally adopted at all the large iron works in Great Britain and on the continent, except in Scotland and in the Cumberland region, where it is supposed to have an unfavorable influence on the quality of the iron. The object of this arrangement is to throw the small ore and coal against the sides of the furnace, and the large pieces to the centre, and it was stated to be essential that the cone when drawn up to its place should have a space of 18 inches between it and the lining of the furnace. From the space thus produced the gas is drawn off for the supply of the hot blast ovens and the boilers, which, in the great majority of cases, were placed upon the ground and not upon piers, and no difficulty is experienced in procuring an adequate supply of gas below by the draught of high chimneys. It was generally stated that the adoption of the cup and cone arrangement had improved the running of the furnaces and diminished the consumption of coal.

The Cumberland region has long been remarkable for the large product of iron from its blast furnaces. Even as early as 1862 a weekly product of over 600 tons had been achieved in one furnace, and although the business has greatly extended in that region, and is still characterized by large weekly products, it does not appear that any improvements have been lately made either in construction or in yield. At Barrow-in-Furness there are six furnaces 15 feet across the boshes, by 42 feet high; and five

furnaces of $17\frac{1}{2}$ feet across the boshes, and $47\frac{1}{2}$ feet high. When working for pig iron designed for the Bessemer process, the smaller furnaces make 300 and the larger 400 tons per week of extra gray pig iron, but this product is very largely increased when the furnaces are running on forge iron, a single furnace having made as much as 700 tons in a week. This remarkable product is due to the admirable character of the ore, which is a red hematite, yielding 60 per cent. on the average, and is smelted with a ton of coke per ton of iron, but when the grayest iron is made the consumption of fuel is undoubtedly greater. Admirable as these works are in construction, and producing annually the enormous quantity of 200,000 tons, there was nothing in the process of manufacture calling for special notice.

But at no point in Europe was the lesson of the superior advantage of good quality more plainly inculcated, for here, on the west coast of England, gray hematite iron was selling for 90 shillings a ton, while on the east coast of England gray Cleveland iron could be purchased for 40 shillings per ton; the one finding a market in the Bessemer process, where only the very best iron can be used, while the other had to be sold in competition with the great mass of inferior pig. But though the iron of the Cleveland region be inferior, it is there that the American iron-master has most to learn. The ore of the Cleveland region is of the fossiliferous variety, yielding 31 per cent. raw, and 42 to 43 per cent. when roasted. The coke is extremely tenacious, enduring a heavy pressure without being crushed. The first furnaces built were about 18 feet in diameter and 55 feet high, making a weekly product of about 230 tons, with a consumption of $1\frac{1}{2}$ ton of coke to the ton of iron, and a temperature of blast of from 600° to 700°. The excellent performance of the stock in the furnace soon led to an increase in its height, with a corresponding increase in the temperature of the blast, and now there are furnaces in operation in the Cleveland district 102 feet in height, 27 feet across the boshes, and driven with a blast of a temperature of from 1,000° to 1,100°, or at least sufficient to melt pure zinc, back of the tuyeres, in from four to five seconds. The consequence is that the consumption of fuel has been reduced to a ton of coke to the ton of iron, and there has been a gain of two per cent. in the yield of the ore, which latter phenomenon is attributed to the use of the Player stoves for heating the blast. In this arrangement the gas is burned in a separate chamber, and only the resulting heat reaches the pipes. Thus all floculent matter is disposed of and the pipes require no cleaning, and their liability to injury is far less than when the flames come in contact with the pipes, subjecting them to the danger of being burned in spots. The pressure of blast is from $3\frac{1}{2}$ to $4\frac{1}{2}$ pounds to the inch, and six tuyeres of $3\frac{1}{2}$ inches diameter usually serve to convey it to the furnace. At the Norton works, where there is a furnace 85 feet high by 25 feet boshes, there were four stoves, containing 60 pipes weighing 126 tons, which heated the blast from a blowing cylinder of 7 feet by 7 feet, making 13 revolutions per minute. The general rule

for blast is that there shall be 1,200 square feet of heating surface for each 1,000 cubic feet per minute.

The effect of this change in the size of the furnace and the heat of the blast in the Norton furnace above referred to was to give a weekly product of 365 tons. All these furnaces have the cup and cone arrangement at the tunnel-head, and the gas is drawn off into a great iron flue forming a kind of cornice or moulding around the top of the furnace, but covered with brick so as to avoid radiation. A proper outlet for the gas is indispensable for the larger product and economical results which have been described. The pipe for conducting the gas to the ground must not be less than 7 feet in diameter, and is lined on the inside with brick.

All the ore of the Cleveland region is calcined in vertical kilns, varying from 24 to 35 feet in height, and from 4,500 to 8,000 cubic feet capacity, charged with ore and fine coal in layers, and consuming about one ton of coal to 24 tons of ore. This calcining might be far better done by the Westman furnace, but unhappily the supply of gas from the blast furnace is not more than sufficient to heat the boiler and stoves. All the usual modes of elevating material to the top of the furnace are to be found in this region, but the pneumatic lift more recently introduced merits attention, as working in a very satisfactory manner. It consists of a cast-iron cylinder of the height of the furnace, made in sections bored out and bolted together, so as to provide a chamber 36 inches in diameter, in which the piston fits loosely, and weighs about half a ton more than the platform and empty barrows. Leather packing is used to render it air-tight. The platform surrounds the cylinder, and is put in motion by the movement of the piston, with which it is connected by wire ropes passing over four eight-foot pulleys at the top of the cylinders. Four barrows of material are raised at a time, weighing from one to two tons, and the upward and downward motion is communicated by the alternate exhaustion and compression of air beneath the piston to the amount of from one to three pounds per square inch, according to the load. A pressure of one pound to the square inch is required to lower the empty barrows. For the calcining kilns, a similar arrangement, but of greater power, is employed.

The early introduction of the high furnaces into the United States would seem to be inevitable, provided the fuel is strong enough to resist the pressure which is involved. Our magnetic, carbonaceous, fossiliferous, and red hematite ores, except in a few instances, are remarkably well adapted to these furnaces, and if it should be found that our admirable anthracite will not decrepitate when subjected to the incidental pressure, it is not hazarding much to predict that the consumption of fuel can be readily reduced to a ton for each ton of iron made.

An analysis of the coke used is subjoined, as a guide to those who employ that fuel:

Carbon	91.42
Volatile hydro-carbons	0.64

Sulphur	1.
Ash	6.66
Moisture	0.28

Among the other curiosities connected with the Cleveland iron, is an analysis of the dust which is deposited by the gas in its passage from the furnace through the stoves and under the boilers.

Protoxide of iron	14.22
Oxide of zinc	10.48
Sulphide of zinc	13.70
Alumina	8.20
Lime	12.32
Magnesia	5.03
Chloride of silicon	4.74
Ammonia	0.70
Thalium	trace.
Sulphuric acid	3.18
Free sulphur	0.17
Silica	22.60
Carbonaceous matter	4.50
Total	99.84

So large a proportion of zinc from an ore which contains no zinc is a phenomenon not unobserved at other places, but has as yet received no satisfactory explanation.

The Player stove was the subject of commendation in the Cleveland region, and appeared to be as satisfactory a mode of heating the blast as any in use. But it is proper to say that an equally high temperature can be procured in other ways.[1] The introduction of a hotter blast into the United States will certainly effect a large saving of fuel, but the effect upon the quality of the iron must in a great measure depend upon the character of the ores employed. Its combination, however, with the high furnaces certainly affords one of the most interesting and instructive lessons in recent metallurgic improvements.

In Scotland, where for so long a time the yield of blast furnaces was in advance of all other regions, no progress seems to have been made, the furnaces rarely exceeding 200 tons per week. An attempt has indeed been made at Gartsherrie to increase this amount by the erection of two furnaces 60 feet in height, but the consumption of fuel has not been reduced, and the yield of the furnace in iron not materially increased.

This is noted here in order to suggest caution in our own progress toward higher furnaces, because the increase in the height of the furnace at Gartsherrie appears to have increased the quantity of solid matter

[1] Stoves made with fire-brick, under Cowper's patent, or modifications thereof, are found to work well, and are growing in favor. They are described in Bauerman's admirable "Manual of Metallurgy" republished by Van Nostrand in New York.

which falls down into the hearth and very much adds to the labor of working the furnace. It has been suggested that a modification in the shape of the furnace might relieve this difficulty, and some new furnaces erected by Mr. D. Adamson, in North Lincolnshire, are cited as an example of the advantages of bringing down the lines of the furnace almost parallel to a very low point, and then drawing them in quickly towards the hearth. But in the absence of a larger experience it would be unsafe to recommend any other course but extreme caution in departing from successful practice.

Passing from blast furnaces to rolling mills, the most striking change presented in the new works is the simplicity of the machinery, its large dimensions, and their arrangements for dispensing with labor in the handling of the material. Reversing mills are generally employed in Great Britain in preference to three-high rolls, but in France it is to be noted that at Anzin, in Isère, three-high trains have been in use for rolling girders since June, 1849. There is also a three-high plate mill at Le Creusot, and the principle of three-high mills appears to be perfectly well understood in Europe, but the reversing mill is generally preferred. Direct acting engines—that is, engines without intermediate gearing, are generally preferred, but at Crewe, in the plate mill the fly wheel was dispensed with; a pair of engines similar to a locomotive engine were used, running at a high speed and geared down so as to give the proper number of revolutions to the train. At Ebbw Vale there is an engine, driving a small train, (running 250 revolutions per minute.) In both these cases the result was entirely satisfactory to the managers. Another striking feature in the rolling mills and in some of the larger steel works was the adoption of the hydraulic crane for moving the masses of metal, and where the hydraulic crane was not used the steam crane often supplied its place. The ratio between human labor, and the quantity of material handled, has thus been greatly reduced, and apparently brought to a minimum, and in the United States, where labor is so dear, the introduction of hydraulic machinery as a substitute for human muscles is an imperative necessity.

The arrangements necessary for this purpose are not complicated, although somewhat expensive. Where an adequate pressure of water, say 300 pounds to the square inch, can be procured, from an adjacent height, as at the admirable works of Naylor, Vickers & Co., in Sheffield, the expense is lessened, but in other places it is only necessary to erect an accumulator and supply the pressure by artificial means; and even the accumulator may be dispensed with by the use of the duplex steam pumps generally employed in America. The steel-rail mill of John Brown & Co., at Sheffield, and the new steel works of Naylor, Vickers & Co., at Sheffield, are admirable examples of the perfection to which this hydraulic system has been carried; and taken as a whole I regard the latter establishment as the best specimen of mechanical engineering which has come under my observation.

Attention should also be directed to a tool for slotting the ends of rails, so that they may be all of exact length, which is indispensable in order to secure a perfect railway joint. The cost of this operation is about two pence per rail, and the machine is not expensive. Another machine for cutting rails cold, at John Brown & Co's., was worthy of observation. It was a circular saw 16 inches in diameter and ¼ of an inch thick, making 20 revolutions per minute and cutting 6 steel rails per hour. Another feature admirable for the order and cleanliness of the mill was the cemetery for rolls not in use, which were all buried in special tombs prepared for their reception under the iron floor of the mill, whence they were easily removed by cranes.

Among the names of those who give dignity to the grand prize of the Exposition stands that of Charles William Siemens for his gas regenerative heating furnace; and although this invention has been long enough in use thus to command the homage of the scientific world, it is only within a few months that it has been introduced for the first time into an iron works in the United States. Its practical success is, however, undeniable, and for the reheating of steel, whether made by the crucible or the Bessemer process, or for the heating of iron, where a clean incandescent heat is required, or for any of those operations in which wrought iron is required to be kept in a melted condition, its necessity is unquestionable. Its merits, however, are not limited by these results, for which it was originally designed, but enable hitherto useless or nearly worthless forms of fuel to be employed with entire success. At Crewe, where coal alone is used for reheating, five hundred weight suffices to do the work of a ton under the old plan, and at the time of my visit they were using half saw-dust, saving thereby one-fifth of the coal, that is to say, two and a half hundred weight of saw-dust was found to be equal to one hundred weight of coal. At the wire works of Richard Johnson & Nephew, as we have already seen, the consumption of coal was reduced from about fifteen hundred weight to eight hundred weight per ton of billets heated, and the waste from 10½ per cent. to 6.9 per cent. At Bolton the manager assured me that the results were equally satisfactory, although he considered it an open question whether, in cases where the waste heat was used for making steam, there would be much economy of fuel by the use of the Siemens' furnace, but he had no doubt whatever as to the saving in waste and the increase of product from the furnaces. Aside from the question of the quality of the iron produced, the Siemens' furnace in the United States will be found of most value where coal is dear, and, above all, at works driven by water power and the surplus heat now allowed to go to waste. The application of the Siemens' furnace to puddling is quite recent. I saw it in operation at Le Creusot, in France, and at Bolton, in England. At the former place the coal, which is an impure kind of anthracite, had required some modifications to be made in the generator, so that the advantages could not be estimated, but at Bolton the furnace worked so much more rapidly than the old furnace that it was necessary to put on three shifts of hands

per day, and no difficulty of any kind was found in the operation of the furnace. I regard it, therefore, as one of the most important improvements to be introduced into American iron works at the earliest possible day.

The success of Siemens has given rise to many attempts to improve the ordinary puddling furnace, and at Bolton I found in operation the Wilson furnace, which differs from the common furnace in having the coal fed in from a hopper over the fuel chamber on to an inclined grate, and with a bridge which causes all the smoke to be consumed before reaching the stack. Although this furnace has been tried previously at other places and abandoned, yet at Bolton it appears to be working well. The consumption of coal was less than a ton to the ton of iron, the number of heats in twelve hours was increased from six to seven, and the waste of the iron was stated to be decidedly less. In case subsequent experience should confirm the promise of the experiment as I saw it, it would seem that in works where the waste heat is required for raising steam, the Wilson furnace could be introduced with more advantage than the Siemens' furnace for puddling.

In the Exposition among the articles exhibited by the Dowlais works was a puddle ball of unusual dimensions, made in the mechanical puddling machine constructed by Mr. William Menelaus, the able and experienced manager of this extensive establishment. A visit to the works proved that no expense had been spared in order to substitute puddling by machinery for the work by hand. A building and engine had been put up expressly for the purpose, and four massive machines erected, capable each of heating a quantity of iron sufficient to produce a ball of six hundred-weight. The puddling vessel is of a shape that would be produced by revolving the bottom of a puddling furnace, and is caused to turn on a horizontal axis resting on firm bearings. The vessel is first charged with iron, either cold or melted, and then lifted by a steam crane and placed on its proper bearings, and as soon as the metal is melted, thrown into gear and caused to revolve. It was expected that the puddling operation would be accomplished by the simple revolution of this vessel, supplied with the products of combustion from a furnace placed at one end. When the heat was completed, the vessel was lifted from its bearings by the crane, the bridge end turned down, and the ball dropped out upon a carriage ready to be taken to the hammer. There were of course many other details, which it is unnecessary here to describe, as the results achieved were not such as to encourage imitation. The first difficulty was found in procuring a lining material which would withstand the chemical action of the metal and cinder, and the mechanical action of the iron from the time it came to nature until it was balled up. Ganister was tried and failed, because the iron produced was invariably cold-short. Titanic ore from Norway was found to stand nearly as well as the ganister, and the iron produced was less cold-short, but with neither could a satisfactory iron be produced. Iron linings failed, because the iron under treatment

adhered to the sides of the vessels; and Mr. Menelaus makes this important statement, that it is next to impossible to prevent puddled iron from adhering to the *clean* surface of an iron lining heated to the temperature necessary for puddling. It was also found that artificial blast was necessary, but notwithstanding over 600 tons of iron were made in these vessels, and the highest order of mechanical talent brought to bear upon the process, neither the lining could be made to stand nor the iron brought up to a merchantable quality.

The problem of mechanical puddling, therefore, still remains unsolved, but the manual labor of the puddler can undoubtedly be considerably diminished by the use of puddling tools or rabbles, moved backwards and forwards around the furnace by a series of levers put in motion by steam or other power. At the Northfield iron works, near Sheffield, such machinery, invented by John Griffiths, was in operation on a single double puddling furnace, in which ten hundred-weight of pig was charged and six heats were made daily by one puddler and two boys helping him. It was claimed that 2,400 pounds of puddled iron was being produced with sixteen and a half hundred-weight of coal, and there certainly was a saving of one skilled workman. And yet it was stated that where these machines had been put into the works, and left to the option of the puddler to be used or not, and the same price per ton paid for the result, the puddlers had declined to use them. But whether because they were really found to be of no service, or because they feared their use would bring down the rate of wages, it is impossible to say.

So far as my judgment goes, I think they could be introduced with great advantage to both masters and men.

At Le Creusot, in puddling white pig iron for rails, they make eleven heats per turn, or two and a half tons, in a furnace with one puddler and two helpers, which is a larger yield than I have any knowledge of elsewhere, but it is certainly not due to any peculiarity in the furnace.

Player, the inventor of the hot-air stove, has also taken out a patent for what he terms a blooming process, by which the entire heat is removed from the puddling furnace in one mass, and carried to the hammer on a suitable carriage, thus saving the expense of separating the heat into small balls. Trials are now being made with this process, but it is yet too early to give any positive opinion as to the result.

Of the value of another improvement, however, made by John Beard, there can be no doubt. This invention consists in placing the grate-bars of the puddling furnace upon two axles, at the front and back of the fire chamber. To these axles a vibrating or rocking motion is given by means of levers, the effect of which is to raise the grate-bars alternately at opposite ends, so that each grate-bar vibrates up and down in an opposite direction to its adjacent grate-bar. The value of this improvement consists in the facility with which the grates are cleaned and freed from all clinker without breaking up the fire. It was already introduced into the Blaenavon works, in South Wales, and those of John Brown

& Co., at Sheffield, where it was stated to give an additional heat from the furnace per turn, and to make a considerable saving in coal.

The manufacture of puddled wire-rods is a very extensive business in Great Britain, but no one has succeeded in naturalizing it upon American soil. With the best grades of charcoal iron it is indeed possible to make good puddled wire rods in the United States, but at a cost too high to compete with the foreign article, in the production of which no charcoal is employed. I visited the works of J. C. Hill & Co., near Newport, in South Wales, and those of Richard Johnson & Nephew, at Manchester. In both these works, a mixture of several brands of coke iron is employed, costing on the average about £4 per ton. Single puddling furnaces alone are used; the charge of iron is 4½ cwt., and the yield from 3¼ to 3½ cwt., made up into five balls, and showing a waste much larger than usual. These balls are hammered under a five-ton helve, to a bloom four inches square, and this bloom is taken hot to a balling furnace, where it is heated and rolled down to the ordinary 1¼-inch billet for wire. The greatest possible care is taken at all stages of the operation, but the result of my observation is, that the puddling furnance is the stage in which the iron receives its proper preparation for a wire rod, and I think I may say that as a general rule, when high grades of iron are to be produced, I remarked a higher standard for the puddled bar than I have been accustomed to see in the United States. The practice of puddling for grain instead of fibre is more general, and I think I cannot be mistaken in saying that the puddle balls are far more thoroughly cleaned of cinder when puddled for grain. At Blaenavon and at Le Creusot, at which works very superior iron is made, the grain of the puddled iron resembled puddled steel more than iron, and it seems probable that we shall hardly attain to the same regularity of product in America until the same careful attention is paid to the puddling process.

The propriety of rerolling old rails seems to be involved in as much doubt in England as in the United States.[1] The general practice, however, is to sell the old rails and purchase new ones, but at Crewe the London and Northwestern Railroad Company, and at Swindon the Great Western Railroad Company have mills for reworking their old rails. There was a concurrence of opinion in both establishments that new iron should be used in the head, and at both the steel-headed rail with old rails in the base was looked upon with favor. At Swindon I saw a beautiful steel-headed rail which had been made by balling up cast-steel turnings in a common balling furnace and placing the resulting bar on top of a rail pile. The fracture was admirable and the weld appeared to be perfect. There seemed also to be a general agreement that the top slab of a rail pile should not be less than one and a half inch in thickness, and two inches is preferred. At Blaenavon puddled steel is used for heads with very satisfactory results, but care is taken that the layer of steel on the finished rail shall not be less than five-eighths inch thick.

[1] See Appendix F.

PROCESSES FOR THE MANUFACTURE OF STEEL.

By common consent it seems to be agreed that the most striking feature of the industry of the present day is the marked advance in the manufacture of steel and its progressive substitution for iron, in all cases where strength must be combined with lightness. Notice has already been taken of the enormous masses of steel in the Exposition, but it was only by observing the infinite variety of forms and purposes to which it was applied, that the intelligent observer was compelled to admit the transition which is taking place from the age of iron to the age of steel. Another conclusion could not fail to be reached from a careful study of the products and processes represented in the Exposition, viz: that good steel can only be made from good material, no matter what process is employed. For the best steel the crucible process still maintains the first rank, and although the Exposition contains some beautiful specimens of material made by other processes, yet it was quite evident that no plan has yet been made sufficiently practical to infringe upon the domain of crucible steel for the more difficult and higher uses for which this metal is required. The process of making crucible steel is too well known at this day to require description at my hands, but like all other branches of the metal business it has of late undergone an immense extension in the size of the works and of the products.

At the establishment of Thomas Firth & Sons, in Sheffield, the old system of making steel is maintained in its integrity, and of a quality unsurpassed by any other maker. And yet here I saw a 12-ton ingot cast for the tube of a Woolwich gun, poured from crucibles containing each about 50 pounds. In order to make a solid ingot it is indispensable that the metal should be poured continuously into the mould at a high temperature, inasmuch as any delay in discharging the crucibles would be fatal to the quality. The difficulty of preparing this quantity of metal in such small instalments so as to reach the mould in due season, and of organizing the gangs of men necessary for its transfer, will easily be appreciated by those who are familiar with the magnitude of the task. The only evidence in these works, besides the masses of steel, of the new era upon which the business has entered, was to be found in the enormous steam hammers, furnaces, and cranes, which had been rendered necessary in order to fabricate ingots of such massive character. So admirable were these arrangements that there seemed to be no greater difficulty in dealing with these heavy masses of steel than with the smallest ingot on the premises. Here the fabrication of cast-steel locomotive tires has just been undertaken, with every possible facility for its successful operation. A cylindrical ingot is first made sufficiently large for six or eight tires; this ingot is then cut in a lathe into sections, each of the shape of a cheese, sufficiently large for a single tire. The steel cheeses thus produced are heated and thoroughly hammered under an immense steam hammer, and, after being reduced in all directions by

this process, are again heated and punched with a conical-pointed punch under another steam hammer. The ring thus produced is enlarged by successive heatings and hammerings until it reaches the size suitable for the tire rolling-mill, where, after being again heated, it is rapidly finished, producing a ring without weld or joint.

Inasmuch as the relative value of tires made by the crucible process and the Bessemer process is still a subject of discussion, I took special pains to compare the toughness of the crucible steel, as shown in the clippings of the fin on the finished tire, with the same clippings from the Bessemer tires, and no doubt was left in my mind as to the superiority of the crucible material; but I do not wish to be understood as saying that the Bessemer material is not good enough for the purpose, and, in view of the relative price, more economical in use, Firth's tires being sold at £45 per ton and the Bessemer as low as £28. The mode of making crucible tires at the works of Naylor, Vickers & Co., was somewhat different, and appeared to be less expensive; and here one could not fail to be struck with the admirable adaptation of mechanical means to the objects in view, and with the very complete arrangements for the production of large masses of crucible steel. Here again was presented the perpetually recurring question as to the relative value of Bessemer steel for special purposes, such as crank shafts and locomotive crank axles, which are produced at these works in large quantities and from crucible steel. Of the value of the latter no doubt seems to be entertained, and the makers of the former insist that their work is equally reliable at a far less cost; but I must again acknowledge that I saw no Bessemer steel in England of equal toughness with the product of the best makers of crucible steel. In the Exposition, on the other hand, there were specimens of Bessemer steel from Sweden and from Austria which appeared to be fully equal in quality to any crucible steel, and these may be the precursors of the coming day when crucible steel will be a thing of the past, but that day has not yet arrived.

The past year may be said also to have decided the substitution of cast steel for iron in guns of small calibres. The peculiar excellence of the Marshall iron is still admitted, but it cannot be denied that cast steel is freer from "grays" or specks, and, in point of tenacity, quite as reliable. When steel is employed for this purpose the barrel is not welded, but is generally bored after being forged to the proper length.

The Chassepot rifles are all being made in this way, but another method, known as that of Deakin & Johnson, is being introduced, with considerable probability of its general adoption. In this process the ingots, after being hammered to about five inches in diameter, are cut into pieces of suitable weight for a gun barrel, and punched in the same manner as has been described for the punching of tires. The blanks so punched are heated and hammered, and then rolled over a mandril into a cylindrical tube about a foot in length, which is again heated and rolled over a mandril into a gun barrel. This process forms the subject

of a patent, although it is difficult to find anything in the process which is novel, except, possibly, in its limitation to gun barrels. It is applicable, however, either to cast steel or to Bessemer steel, the latter being generally employed.

The Bessemer process is, of course, the great feature of our day in this department; and in order that it might be treated in such detail as its importance demands, it was deemed by the committee best to make it the subject of a special report, and this duty was confided to Mr. Fred. J. Slade, an American mechanical engineer, who had already devoted several months to its careful study, in the interest of the American patentee. His report is hereto annexed, and will be found fully to justify the confidence of the committee in intrusting him with this important duty. I have verified the accuracy of his statements by extended personal examination, and it is only necessary for me to add one or two general conclusions at which I have arrived. The first is that the Bessemer process will not, as Mr. Bessemer originally supposed, supersede the puddling process, which appears to be, as yet, the only method applicable to the conversion of by far the larger portion of the pig iron made into wrought iron; because by far the larger portion of the pig iron made is of a quality not good enough for the Bessemer process, which, in the absence of sulphur and phosphorus, is absolutely exacting. It is true that an antidote may yet be found for these two poisons, in which case the area of the Bessemer process would be enormously extended. But even then there would be a limitation to its general use (and this is my second conclusion) arising from the uncertainty as to the quality of each particular cast, requiring a special test for each in every case where it is to be subjected to great strains. But, even when this precaution is taken, it is found that in the manufacture of tires and of gun barrels there is a very considerable percentage of failure from undiscovered flaws, which show themselves in the cracking of the ingot when subjected to the severe test of the steam punch. Hence, in my judgment, it is not safe to use Bessemer metal in any case involving the security of life or limb, unless, in the process of manufacture, it has been subjected to such tests as will certainly show all its defects.

I think it is safe to use it for tires and for gun barrels that have been made by the punching process, but I should think it unwise to employ it for solid railway axles made in the ordinary way. If punched and made hollow, this objection would not apply, and doubtless it would not be difficult to devise a method of making a solid axle from Bessemer steel that would be free from objection.

In view of the small amount of Bessemer steel as yet produced in the United States, we are struck in Europe with surprise at the enormous provision made for its supply; and it is quite evident that the business is overdone, and, contrary to all past experience, the inventor and the public at large seem to have profited by its introduction at the expense of the manufacturer.

As an adjunct to the Bessemer process, the Parry process must be mentioned, having for its object the conversion, in a cupola furnace, of wrought iron which had been freed from phosphorus and sulphur by the puddling process into pig iron adapted for the Bessemer process. For this method of operation extensive works were erected at Ebbw Vale, but they have been abandoned, and the patent has been purchased by Mr. Bessemer.

This process would have very considerable value if the metal could be tapped from the cupola in the form of steel instead of pig iron, but this does not appear to have been practicable, inasmuch as the product was a white pig iron, containing two per cent. of carbon. A charge of 22 hundred-weight was worked at a time, and required from 55 to 75 minutes for its treatment, which involved a waste of twelve per cent. It might possibly be used advantageously for the conversion of the ends of Bessemer rails into pig, in case they should ever become so cheap as to warrant the operation. It might also be used for melting down the metallic sponge, which can be made by cementation from our rich ores in America, but certainly without advantage in point of cost, unless the product should have qualities attainable in no other way. The production of steel from the cupola furnace is still a desideratum to be attained, but among the possibilities of the future.

A careful study of the Exposition showed but two other processes for making steel worthy of notice, and both French: the one patented by A. Berard and tried at the forges of Montataire; the other that of Emile and Pierre E. Martin, in operation at Sireuil. In both these systems cast steel is made in a reverberatory furnace. In Berard's process the conversion of the pig iron into steel is sought to be achieved by subjecting the melted metal alternately to a decarbonizing and recarbonizing flame, for which purpose it is necessary to employ blast. He uses a Siemens' furnace, and avails himself of the changes of current required in working the regenerators to affect the changes of flame. The furnace is divided by a bridge into two halves, and he thus operates upon two masses of iron at the same time, one of which is freshly charged, while the other contains material which is nearly decarbonized. Some specimens of Berard's steel were on exhibition, and although creditable in themselves, it was generally understood that he had not yet succeeded in making steel regularly for market. The Messrs. Martin, on the contrary, were not only making steel regularly at their own works at Sireuil, but the process is also in operation at two of the largest works of France—Le Creusot and Firminy—and is in process of erection at various other works in Europe, and arrangements have been made for its immediate introduction into the United States. In this process the pig iron is deprived of its carbon by the addition of pieces of wrought iron or steel either in the form of shingled puddle balls, or of scrap. The quantity, however, of wrought iron necessary to reduce the carbon to the required limits, is much less than would be inferred from the con-

sideration of the quantity contained in the pig, and does not in practice much exceed the quantity of pig itself. A charge of gray pig or of spiegeleisen is melted in a Siemens' furnace, having a bed hollowed out to contain it, and is allowed to remain about half an hour after fusion to bring it to an intense white heat; portions of malleable iron previously brought to a bright red heat are then added in successive charges of about 200 pounds, at intervals of twenty minutes to half an hour, each charge being thoroughly melted before the next is added. After two or three such additions, ebullition commences in the bath of metal, and continues till the carbon is wholly removed from the pig. The exact condition of the metal is ascertained from small proofs taken from the charge, after each addition of iron towards the end of the operation. These are run into a small ingot mould, and when cooled to the proper heat, hammered into a plate, about $\frac{5}{16}$ of an inch thick by 5 inches in diameter. When the decarbonization is completely effected these proofs will bend double cold, and show a fracture quite fibrous. A quantity of pig, generally of the same kind as was used for the preliminary charge, is then added in such proportion to the amount of iron in the furnace as to give the desired hardness to the steel, according to the use for which it is required. When this is melted the bath is well stirred to insure homogeneity in its substance, and a final proof taken, which is treated in the same manner as the others, and gives reliable evidence as to the state of the metal before pouring. This enables the quality to be very exactly adjusted to the degree of hardness required. Should it be too soft, more pig is added, while if it is too hard, the mere waiting from a quarter to half an hour will materially soften the metal. Arguing from this fact, Messrs. Martin claim that under the influence of such a high temperature, the carbon is to some extent spontaneously disassociated from the iron, and attribute in a measure to this the fact that so small a proportion of wrought iron is required to effect the decarbonization of the pig. The coating of scale formed on the iron in the preliminary reheating which it undergoes before being charged into the furnace, also assists in the removal of the carbon. When the metal has been brought to the desired condition, it is tapped off at the rear of the furnace into ingot moulds placed on a railway car, and thus brought successively under the gutter.

A considerable number of specimens of steel made by this process were exhibited, ranging in hardness from a metal too hard to be touched by a tool to a true wrought iron, intended to be used in the manufacture of armor plates. At Messrs. Martin's works, at Sireuil, the process has been in regular operation during the past two years for the manufacture of gun-barrels, and some remarkable specimens of these were exhibited. Thus there was one that had been tested with very large charges of powder and a heavy weight of shot, which, by very palpable bulging just behind the balls, testified as to the softness and toughness of the metal. In another, which had been burst by a similarly severe charge,

the metal had merely torn open for a certain length of the barrel, and the lips so formed were simply folded back 180″, without any sign of cracking. There were also shown specimens of tool-steel, of excellent fracture, castings of pieces of machinery, such as gears and framing, and a large tube for a cannon of extremely soft metal, or melted iron, as it is named.

The hardest variety of metal, called by the patentee "mixed metal," is considered suitable for castings which do not require to be worked by tools, but where great strength is required, such as hammer blocks and anvils, large gears, &c. By a subsequent process of annealing or dis-carbonization, carried on in a gas furnace, under the influence of an oxidizing flame, these castings may be softened so as to be quite malleable and easily worked, and they then retain the advantage of being free from blow-holes. This metal is produced by adding to a preliminary bath of say 1,600 pounds of pig 2,400 of wrought iron, and adding at the end 1,200 pounds of pig. For tool-steel, to a bath of 1,600 pounds of gray pig would be added 2,600 pounds of puddled steel from the same pig, and at the end of the operation 400 to 500 pounds of spiegeleisen. For homogeneous metal, the preliminary bath at Sireuil is 1,200 pounds of spiegeleisen, to which 2,000 pounds of soft iron, puddled to grain, from the same pig, is added, and at the end of the process 200 to 300 pounds of the same pig is charged, to give the requisite amount of carbon. The softest metal of all, which, however, has not as yet been made an article of regular manufacture, is made in the same way, with the exception that the final charge of manganiferous pig is but 5 per cent. of the contents of the furnace. With certain kinds of gray charcoal pig this proportion rises, however, to 20 per cent., since under the influence of the high temperature they refine spontaneously with great rapidity.

Messrs. Martins' patents also cover the use of ore either with or in place of the wrought iron or steel used for removing the carbon from the pig, and when this is used the progress of the operation is much more rapid. It has the objection, however, that the slag formed attacks violently the bricks forming the sides of the furnace, and therefore requires frequent renewals.

This process has the great practical advantage that all the scrap arising in the manufacture of any product, such as the ends of bars, &c., is readily remitted to the furnace and immediately returned in the form of useful ignots.

The flame in the furnace is kept always slightly surcharged with gas; an effect which the use of the Siemens' furnace renders easy and certain, and by this means the waste of the metal is always moderate.

For the production of soft steel suitable for gun-barrels or for tires, this metal already enjoys considerable reputation in Europe, and, indeed, were it not for its excellent quality, it would be impossible to sustain the manufacture at Sireuil, where there is neither iron nor coal, the latter being brought from England and the former from various parts of *France.*

The results here stated were verified by a personal residence of Mr. Slade during several weeks at the works at Sireuil, and the regular and commercial success of the process was in that way seen to be fully achieved.

It is not asserted that cast-steel can be made as cheaply by this process as by the Bessemer; but where a product of definite quality is to be produced day by day, without rejections to any considerable extent, the Martin process has a decided advantage over the Bessemer, and in comparison with the crucible steel is decidedly less expensive. Its chief drawback would seem to lie in the difficulty of keeping the furnace in order, and only the most refractory materials will withstand the high heat required for its operation. As much as five tons of steel have been produced by this process at a single heat, and there is no difficulty in combining the product of several furnaces where larger masses are desired, inasmuch as the temper of the heat in each furnace can be brought and maintained to exactly the same standard. It would seem also to present the best solution yet devised for the difficulty experienced by the accumulation of the ends of Bessemer steel rails, inasmuch as these can be used in lieu of the puddled iron required by the process. It is possible, also, to use old rails in the same manner, and, indeed, any old scrap, but the resulting quality of the steel will, to a great extent, depend upon the quality of the old iron so used.

A visit to the works of Messrs. F. F. Verdié & Co., at Firminy, showed, in confirmation of facts gathered from other sources, that the steel manufacture of France, instead of being in the advanced degree of perfection, often supposed in our country, has been but very moderately successful. These works were established for the manufacture of crucible steel and forgings on a rather large scale, but to-day the production of steel by this process has been entirely abandoned, and with the exception of some puddling, all the steel now made is by the Martin process, for which three furnaces are now in operation and others in course of erection. The same thing appears to be true at other works, and it is quite certain that no considerable amount of good cast steel is produced in France.

In order to enable a comparison to be instituted between a first-class Swedish iron and Bessemer steel, containing various degrees of carbon, I annex (Appendix D) the tabulated results of a series of experiments made by David Kirkaldy, at his well-known testing and experimenting works in London upon 11 bars of billet iron from the Degerfors iron works in Sweden, and 12 hammered bars of Fagersta Bessemer steel of various degrees of hardness, resulting from different percentages of carbon, which are indicated by the stamp on the bars; that is to say, 0.3 means three-tenths of one per cent. of carbon, 1.2 means one per cent. and two-tenths, and in like manner for intermediate stamps.

WORKS FOR THE PRODUCTION OF IRON AND STEEL.

The description of the large mass of steel and iron exhibited in the Exposition has led, incidentally, to an account of the magnitude of the iron works of Krupp. But this report would fail to give an adequate idea of the magnificent scale upon which the metallurgic industry of Europe is conducted at the present day, if reference should not be made to other establishments in other countries. In France the most extensive works are those of Le Creusot, near the centre of the empire, which is especially commended in the report of the jury of recompense for organizations which best develop a good understanding between masters and workmen, and secure the material, moral and intellectual welfare of the operatives.

In 1845 the product of Le Creusot was about 60,000 tons of coal and 4,000 tons of iron. At the present time the production is 250,000 tons of coal and 130,000 tons of cast iron and 110,000 tons of wrought-iron. The works cover an area of 300 acres, of which more than 50 acres are in buildings, in which mechanical operations are carried on. The coal is mined in the immediate vicinity, and the quantity of ore which the region now furnishes is stated to be 300,000 tons per annum, but my impression is that this includes a large quantity brought from Algiers and Elba. There are 15 blast furnaces of large dimensions, fed by 160 coke ovens, and using the blast of seven blowing machines of 1,350 horse power, and 10 other engines for other purposes. The forge contains 150 puddling furnaces, 85 heating furnaces, 41 separate trains of rolls, 30 hammers, 85 steam engines of 6,500 horse power in the aggregate. This mill is all under one uniform roof, made of iron, and is about 1,400 feet in length, and is altogether in appearance and construction the most complete rolling mill in existence. And it is a remarkable evidence of the intelligence and courage of Messrs. Schneider & Co., the proprietors, that within the last few years they have deliberately abandoned their old works and machinery, and erected an entirely new establishment, in order to avail themselves of all the modern improvements in machinery and process. The machine shops require engines of 700 horse power for their operation, and contain 26 hammers and 650 working tools. The total number of workmen employed is 9,950, being, by a remarkable coincidence, the precise number of horse power represented by the steam engines in the works; that is to say, each man employs a machine power of one horse in addition to his own labor, showing the wonderful extension of human power which in our day has been realized out of the steam engine. 45 miles of railway, 15 locomotives, and 500 cars are required for the local operation of the works, and the enormous quantity of 1,400,000 tons of traffic is annually moved at the central depot of Le Creusot. All parts of the works are in communication by telegraphic wire. The total value of the productions is now about $7,000,000 per annum in gold.

On the whole these works may be regarded as the best model offered by Europe for the study of the iron business as it is, and they are not only an honor to the proprietors, but one of the chief glories of France.

The works of Petin, Gaudet & Co., are distributed among several establishments, which in the aggregate employ 5,200 men and a steam power of 6,000 horses. The annual production is about 50,000 tons of iron and steel, of the value of $7,000,000 in gold.

There are several other establishments in France which approach very nearly to these large proportions, and considering the disadvantages in point of fuel and ore under which the business is carried on, as compared with Belgium and England, the present development of the iron industry of France, amounting to an annual product of 1,200,000 tons of pig iron and about 800,000 tons of wrought iron, is one of the most striking features of the industrial progress of France during the present century.

In Belgium the iron industry has made remarkably rapid strides, the production of pig iron having advanced from 134,563 tons, in 1845, to 449,875 tons, in 1864, and there are many establishments in Belgium organized on a scale comparable to the best works in other countries. That of Cockerill at Seraing, in which the government is directly interested, produces 50,000 tons of pig iron, 26,000 tons of bars, and 5,000 tons of steel annually, consuming 80,000 tons of coke and 146,000 tons of ore, and mining 260,000 tons of coal.

In Prussia, the works of Krupp have already been referred to, and there are many other extensive establishments organized upon the best principles of modern construction.

The Phœnix works near Ruhrort, for example, produced during the last year over 50,000 tons of pig iron, and 40,000 tons of wrought iron, with 11 blast furnaces and the corresponding number of puddling furnaces. The total production of iron ore in Prussia, for the year ending 1865, was over 1,700,000 tons, which represents a production of iron of about 770,000 tons.

In England there are many works approaching in capacity to Le Creusot, among which may be enumerated the Dowlais and Ebbw Vale in South Wales, those of Bolckow, Vaughan & Co., in the Cleveland region, and of the Barrow Hematite Iron and Steel Company at Barrow-in-Furness, and of John Brown & Co., at Sheffield. A production of 2,000 tons per week is achieved in each of these vast establishments. Large towns are required to house the workmen and their families; hundreds of miles of rails and thousands of cars are appropriated to their special use. The human mind is lost in wonder at the combination of material and intellectual elements required for the organization and conduct of such gigantic operations, and standing in the presence of tools which seem formed to shape the universe, and of an artificial power which, in the aggregate, is too vast for any other estimate than by comparison with the force which moves the earth in its orbit, the triumph of man over matter is realized to an extent making it possible to comprehend in some degree the omnipotence of Deity himself.

One striking consequence of the vast size which has been given to particular works is their general transfer from individual ownership to that of stock companies; and although this transfer is not considered favorable to the economy of manufacture, the saving produced by production on so large a scale would seem to counterbalance the advantages in point of cost which are connected with individual ownership. Nor is this feature of association of ownership peculiar to any one country, but may be said to be the general rule in all. In England, owing probably to the business being overdone, none of these companies can be said to have achieved a pecuniary success, and the shares of all of them are at a considerable discount. This fact, producing profound dissatisfaction on the part of the owners, coupled with the feeling of restlessness and discontent with their wages among the workmen, has paved the way for the consideration and discussion of the problem, whether in these large establishments the true relations between capital and labor have been established, and in what way they may be placed upon a sounder basis, avoiding the ever-recurring contention between masters and men, which culminates in strikes injurious alike to both classes. The question has already stepped beyond the limits of private discussion, and governmental commissions are now investigating both in France and in England the facts and the principles upon which the organization of labor rests at this day, the points in which there is a collision between it and capital, the wrongs, if any, upon either side; with a view to such legislation as may render the march of industry regular, and profitable to all concerned. In some establishments engaged in the mining of coal and other branches of industry, outside of the iron business, the system of co-operation, as it is termed, has been introduced, with manifest advantage. But in all these cases the business is a profitable one, and has never yet been subjected to the strain which will attack the system when it is forced to deal with losses instead of profits. The general plan adopted in these co-operative establishments, such as Crossley's great carpet factory in England, is to reserve to the capital a fixed rate of interest, as high in some cases as 15 per cent. per annum; next to pay to the workmen a fixed rate of wages, being usually those which were in force at the time of the introduction of co-operation into the works, and to divide the surplus, if any, between capital and labor, on such terms as may be agreed upon, but usually in proportion to the amount of each employed during the year. There is a wide difference of opinion as to the practicability of introducing this system into the iron business, and there is a fear that it would not stand the trial to which it would be subjected in the long periods of depression to which the iron trade has hitherto been invariably subjected, and from which the co-operative system would not relieve it, because there would still be the same competition between the several co-operative associations, and the several nations, as now exists. Under the present system the capital is the first to lose its profits, and then comes the reduction in the wages of labor. Under the new system the reduction would fall first upon labor,

or in strict equity there would be the same percentage of reduction upon the earnings of capital and labor. It is feared that the laborer would not look with content upon any reward to capital under such circumstances, and that the old warfare between the two would thus be renewed.

On the other hand, it is believed that by the obvious harmony thus established between the interests of capital and labor, the latter would be led to see that the co-operation of the former is indispensable for the payment of wages at all, and that any attack upon capital or any diminution of its quantity would be a direct attack upon labor, by depriving it of the fund out of which it is paid, and that the conservation of capital would thus become so apparent as the highest interest of the laboring class that strikes would cease, and even in bad times, from the steady employment thus insured, the labor would be better paid than under the present intermittent system. It is urged, moreover, that the personal interest thus excited in the workman would lead to greater economy in the manufacture, and bring down all waste to the minimum, and that it would be possible to establish such intelligent relations among the owners and workmen of the several co-operative establishments, that over-production would be checked by common consent, in time to prevent the serious losses to which it now subjects the industry of the world. It is quite certain that this latter end is achieved in an imperfect degree even in present practice. In Scotland the number of furnaces in blast during the present year has been very considerably reduced, with a corresponding reduction in the enormous stock of iron which had weighed down the prices below the cost of production. In France, by a resolution of the Ironmasters' Association, a reduction of six per cent. was inaugurated in the early part of the present year, and there is a general recognition of the necessity and wisdom of this course in times of over-production among the iron-masters of Europe. And it is impossible to see that there would be less discretion exercised, or a less prompt remedy applied, if the workmen had such a direct relation to the business as to enable them to feel that it would be better to work less days at the old rate of wages, than more days at a reduced rate, producing precisely the same pecuniary result.

No intelligent observer can fail to remark the universal cry which comes up from the laboring classes in all parts of Europe for the reorganization of the relations of capital and labor. In England it has shown itself in strikes long continued and in all branches of business, reducing the workmen to beggary, and destroying the profits of capital to such an extent that, in a spirit of self-preservation, it takes flight where it can from the walks of industry, and remains unemployed rather than incur the risks and the anxiety of its uses in active business. In France, where, as will be hereafter seen, the organization of a strike is full of difficulties, the same longing manifests itself, not merely in the organization of minor co-operative associations for the supply of the necessaries of life, the erection of houses, and the production of goods, but in a literature which

seeks to analyze the social phases of industrial life and develop some better system for its reorganization. In the course of this almost microscopic examination of the social relations, property has been pronounced to be robbery, communism has been advocated as the remedy for all the social evils, and the autonomy of the individual lost sight of in the attempt to promote the welfare of mankind.

In Germany, on the other hand, under the practical guidance of Schultze Delitch, there have been established, up to the year 1865, 180 associations, with about 10,000 members, for the supply at wholesale prices of the raw material required by the members of the association in their several trades. These associations consist principally of shoemakers, carpenters, and tailors, and their business amounts to about 2,000,000 thalers[1] annually. There were fifty "magazine" unions, comprising about 1,000 members, and doing a business of about 500,000 thalers annually, having for their object the sale of goods produced by the members of the association in a common store. There were also 26 co-operative associations for the production and sale of finished wares on common account, some of which appear to have been successful, while others have failed to realize the expectation of the members; and as this is the only feature of the Schultze Delitch system which has not proved successful, it is well to note that all the associations were organized independently of any existing business or capital employed in its conduct. They proceed upon the basis of disassociation from capital, as such, in the management of the business, and although the founder still expects to achieve successful results with associations formed on this basis, it would seem to be too wide a departure from the experience of mankind in all times to dispense with the watchfulness and patient scrutiny with which capital guards itself from destruction. Of co-operative stores there were, in 1865, 157. These are said to have been of slow growth at first, but are now rapidly extending. But the great success of Schultze Delitch has been in the organization of his credit and loan associations, of which, in 1865, there were 1,300 in existence, with more than 300,000 members. These "credit banks," as they are commonly called, are formed by the workmen themselves, who are supposed to be without any capital of their own. The capital of the bank is procured by the subscriptions of the members, payable in instalments, and by loans contracted on the credit of the association. Of course the share capital can only be slowly accumulated, but experience has shown that loans made to the association are quite safe, because each member is absolutely liable for all the debts, and the funds of the bank are only loaned to its own members, within limits restricted by the nature of the business to be carried on by the borrower, and after a rigid scrutiny of his character. The cardinal rule in the conduct of these banks is to take the minimum of risk and the maximum of responsibility. This report is not the proper place to enter into the history and details of management in these credit banks, but in

[1] Each about 75 cents in gold.

order to show the progress of the co-operative movement in Europe, I append a brief statement of the business of 498 of these banks, whose statistics happen to be accessible. These banks had 169,595 members, and the total amount of money advanced to them during the year 1865 was 67,569,903 thalers, or, in round numbers, $50,000,000 in gold. The total income of these banks, mostly, of course, in interest paid by borrowers, was 1,401,896 thalers, of which 699,558 thalers was paid for interest by the banks on money which they had borrowed, and 316,403 thalers was absorbed by the expenses of management. The total losses were 20,566 thalers, and the net profits were 371,735 thalers. The share capital accumulated by these banks amounted to 4,442,879 thalers, the borrowed capital amounted to 11,154,579 thalers, and the savings deposits of the members amounted to 6,502,179 thalers, and a reserve fund of 409,679 thalers had been accumulated to meet losses. When it is remembered that these banks were started by workmen without any capital, and it is observed that the accumulations of capital, deposits, and reserve funds exceed 11,000,000 thalers, or $8,000,000 in gold, the beneficent operation of the principle upon which they are founded will be appreciated, and some conception may be formed of the wonderful economy which will be introduced into the industry of the world when it becomes the interest of each man not only to produce the best possible result from his own labor, but to see that his fellow-workman does the same thing. In such a reorganization of industry the eye of the owner will be literally everywhere, and the loss either of time or of material will become almost impossible. This topic of co-operation is introduced here because in the Exposition there were constant evidences not merely of its importance, but of its becoming the leading social question of our day and generation. A special prize was constituted in favor "of persons, establishments, or localities which, by an organization of special institutions, have developed a spirit of good feeling between those who co-operate together in the same labors and have secured the material, moral, and intellectual welfare of the workmen." Although Schultze Delitch was not an exhibitor, and no application for this prize was made on his behalf, and the special jury who had this order of recompense in charge lost the great opportunity of making themselves illustrious by voluntarily recognizing the greatest benefactor of the human race in our day, the labors of Schultze Delitch and the success which has attended his system, based as it is upon a profound knowledge of human nature, and the laws of social science, will survive the memory of the Exposition, and erect this monument in the reorganized structure of modern society.

In the United States, strange to say, we lack the legislation, either national or State, which makes it possible to introduce the co-operative system in any of the forms which the experience of Europe has shown to be practicable. In most of the States it is true that there are general laws of incorporation, but these do not meet the case in which a proprietor wishes to divide the profits with his workmen without making them partners, or giving them a voice in the management of the busi-

ness. It is a subject which demands immediate attention, if it is expected to prosecute the iron business, or any other branch of industry, without the perpetual recurrence of strikes; and in order that the experience of older nations may be availed of, I have added to this report in an appendix (E) a transcript of the Prussian, French and English laws on this subject.

PRODUCTION OF IRON.

Originally the geographical position of the ore, and the natural avenues of transportation, determined the establishment of iron works, when the fuel employed was wood, which was to be found everywhere. But the demands of modern civilization soon outran the narrow bounds imposed by the supply of charcoal, and in our day the controlling element in the production of iron is the possession of mineral coal. And, throwing out of consideration the moderate quantity of iron still produced by charcoal, the iron business in Europe is found to be developed substantially in proportion to the quantity of coal possessed by the respective countries. A glance at the geological map of the world shows that within the limits of temperature favorable to active industry, the deposits of coal are widely distributed throughout Great Britain and the United States. In France there is but a limited area, and of irregular formation. In Belgium there is a larger coal field, but in veins of very moderate size. In Prussia, in the neighborhood of the Rhine, there is a small but valuable deposit of coal, while in Russia there is a considerable carboniferous area, the ultimate value of which is not yet well determined. The productive powers of these several coal fields are now pressed to limits approaching very nearly, if not quite to their ultimate capacity. In Great Britain the production in 1866 reached 101,630,500 tons; in France, between 11,000,000 and 12,000,000 tons; in Belgium more than 12,000,000 tons; and in Prussia, in 1865, 18,000,000 tons were produced.

The statistics procured at the Exposition have enabled me to construct the following table of the production of iron in the world in 1866, and there is every reason to believe that the figures given are substantially correct, as estimates were resorted to in only one or two cases, and those based upon former official returns:

Countries.	Pig iron, tons.	Wrought iron, tons.
England	4,530,051	3,500,000
France	1,200,320	844,734
Belgium	500,000	400,000
Prussia	800,000	400,000
Austria	312,000	200,000
Sweden	226,676	148,292
Russia	408,000	350,000
Spain	75,000	50,000
Italy	30,000	20,000
Switzerland	15,000	10,000
Zollverein	250,000	200,000
United States	1,175,000	882,000
	9,322,047	7,005,026

Allowing for the production in barbarous countries, and something for the use of scrap iron, it may be stated in round numbers that the production, and consequently the consumption of the world has reached 9,500,000 tons of 2,240 pounds each, or 21,280 millions of pounds; so that if the population of the world has reached 1,000 millions, the consumption is a little over 20 pounds of iron per head. A careful calculation, after allowing for the iron exported, shows that the consumption per head in England is 189 pounds of iron. The consumption in Belgium has reached about the same limits. The consumption in France is 69½ pounds per head, and in the United States not far from 100 pounds per head. If the industry of the whole world were as thoroughly developed as in Great Britain, the consumption of iron would reach nearly 90,000,000 tons per annum. If brought to the standard of the United States, a little less than 50,000,000 tons per annum would answer; or if to that of France, a little over 30,000,000 tons would be required; figures to be increased further by the steady increase of population in the world.

It will be interesting, therefore, to inquire into the sources of future supply possessed by the nations upon whom this great demand must come.

Sweden possesses exhaustless supplies of the very richest and best kinds of primitive ore, but she has no coal, and a heavy expense for transportation must be incurred in bringing coal and ore together, and, as a general rule, it is found more economical to transport the ore to the coal than the coal to the ore. The limits of the manufacture of iron by wood have long since been reached, and hence Sweden can only be looked to as a source of supply of ore to other countries possessing mineral fuel when their iron mines are too heavily drawn upon.

In Russia, also abounding in immeasurable supplies of ore, there is a possibility, but not much probability, that mineral coal may be developed to an extent sufficient for its own supply of iron. The production of charcoal iron is also capable of some, but not of indefinite extension.

The same remark applies to Austria and the states of the Zollverein. In Italy there is no coal, and hence its rich ores are in the same category as those in Sweden, only far less abundant. Algiers abounds in ore, which has to be transported to the coal. Spain is rich in ore, and has a carboniferous formation on its northern borders, but no attempts have been made to render it available for the production of iron. In France the present manufacture of iron is only maintained by the aid of the importation of coal to the extent of over 7,000,000 tons, and of 495,000 tons of iron ore in 1867.

In Belgium, the size of the coal-field, the vertical character of the veins, and their small thicknesss, render it impossible that there should be any very considerable extension of the business, at least if the supply is to endure for any protracted period. Already it is estimated that Belgium produces as much coal as France, two-thirds as much as Prussia, and one-eighth that of Great Britain, out of a coal-field only ninety-seven miles in length, and twelve miles in breadth at its widest point, and in

veins of from thirty inches to three feet thick. Belgium is already an importer of ore, and although it is quite evident that it will be the seat of a vigorous and possibly increasing metal industry for years to come, it has no resources adequate for serious competition in the supply of the greatly increased quantities which the world will yet require.

Prussia has a somewhat larger supply of coal than Belgium, and is remarkably rich in quantity and quality of her iron ores, but it is scarcely possible that in the future she can do more than supply her own wants. Upon England, then, so far as Europe is concerned, still rests the great burden of supplying the world with iron, if the supply is to come from Europe at all. It has been seen that already nearly one-half the total consumption of the world comes from within her borders. In 1866 she was able to furnish 9,665,013 tons of iron ore, and only imported 56,689 tons.

A careful survey of the sources from which her ore is derived leads to the conclusion that in Wales the local supply is not adequate to the present consumption, and large quantities are transported thither from other parts of the kingdom. The natural limits of production have therefore been reached in Wales, although there will probably be a still further extension of the business in that region either with domestic or foreign ores, in consequence of the possession of enormous supplies of admirable coal available for the furnace without coking. The Staffordshire region, by common consent, has reached its culminating point; and a careful consideration of the local supply of carbonaceous ore in Scotland would seem to indicate that not much extension of the business is possible in that region, except at much higher prices than now prevail. The main reliance in Scotland has heretofore been upon its blackband iron ore, "and the development of its iron trade has been co-extensive with the exploration of that famous mineral, furnaces following everywhere in the wake of its discovery. The clay bands are in such small seams, and of such irregular character, that the business would soon languish and be greatly reduced if dependent upon them alone. The thickest and best seam of blackband, commonly called the 'Airdrie,' is now substantially exhausted, and the reliance is on seams of no greater thickness than eight inches. Blackbands are notoriously irregular, and are not found uniform in thickness; for example, the Airdrie blackband occupies but a small portion of the space allotted to it in the Lanarkshire coal-field. A more notable example of caprice of blackband is to be found in the slaty band, which occurs occasionally in patches of irregular thickness, sometimes six inches and sometimes six feet in thickness; but there is always something to mark its position, either a coal or iron stone. Indeed, all the iron stones in all portions of the coal-field are erratic. They are persistent throughout in no field, yet it is a singular fact that we have in all the fields blackband iron stone." This extract from a paper of Ralph Moore, a government mining inspector in Scotland, is made for the double purpose of showing how impossible it

is that there should be any considerable increase in the annual product of Scotch iron unless foreign ores are brought to utilize the unlimited supplies of admirable coal which exist in that country; but with the further object of giving some information, which may be of use in the development of the blackband iron ore which has been recently discovered in Schuylkill county, in Pennsylvania, the value of which to the country can hardly be exaggerated, if it should prove to be in quantity and quality equal to its British prototype. An analysis of the best Scotch ore is here annexed—rather out of place, but too valuable as a guide to be dispensed with:

	Raw.	Roasted.
Protoxide of iron	49.82	27.10
Peroxide of iron	....	60.1
Lime	1.67	2.7
Magnesia	2.33	3.8
Alumina	1.52	2.4
Silica	2.40	3.9
Organic matter	7.60	....
Moisture	0.32	....
Carbonic acid	34.34	....
	100.00	100.00
Iron, per cent	38.75	63.1
Specific gravity	2.857	....

There still remains upon the east coast of England the great Cleveland region, and upon its west coast the Cumberland or red hematite region. The latter is now yielding about 1,400,000 tons of ore per annum, taken from beds of irregular shape and formation, in or adjacent to the limestone. There are certainly no signs of exhaustion yet apparent in this wonderful district, but all analogy leads us to doubt the permanency of these irregular beds, formed in pockets in the rocks, without any regular walls to indicate their continuity. Besides, the extremely good quality of this ore and the value of the iron which it produces will always restrict its use to those better purposes for which a high price is paid, and naturally withdraws those mines from any competition in the supply of the great mass of iron required by the world for ordinary purposes. Not so, however, with the Cleveland region, where the ores exist in beds of from eight feet to fifteen feet in thickness, in the lias or oolitic formation, extending over a tract of country forty miles in length and fifteen miles in width. This ore is lean and the quality of the iron inferior, but by the application of a high order of skill, a quality is produced sufficiently good for the ordinary purposes of commerce, and at a cost below that of any other locality in the world. The consequence has been that, since the erection of the first blast furnace in 1850, 125 furnaces have been erected, and fourteen more are now in process of erection; twenty-seven rolling mills, and a large number of foundries and

iron ship-building yards are in operation, and cities have grown up with a rapidity and to a size that would strike even a western pioneer with surprise. The present production exceeds a million of tons per annum, and it is difficult indeed to assign any limits to its future growth.

But there is one limitation which applies to the whole question of the production of British iron, and that is, her ability to supply coal on the scale of consumption already beyond 100,000,000 tons per annum. This question has received the serious attention of the British Association for the Advancement of Science, and Mr. Gladstone, by one of those happy ellipses characteristic of men of genius, has coupled the extinction of the national debt with the exhaustion of the supplies of fuel, evidently acting under the idea that an honest man ought to pay his debts while his capital lasts. It is presumed, however, that there is still margin enough for the addition of the "Alabama claims" to the sum total of indebtedness, without seriously interfering with the means of payment which the coal-fields afford.

So far as the production of iron is concerned, and so long, at least, as any human being now in existence may have an interest in the question, I see no good reason to doubt why England should not maintain her position, as the source from which one-half the required amount will be obtained; but beyond this I do not think that she can or will go, from the intrinsic difficulties of producing the required supply of materials and labor, without an enormous increase of cost. There will, therefore, remain a very large deficiency, which must be supplied from some other source, and that source can only be the United States of America, for in no other quarter of the globe are the supplies of ore and coal sufficiently large, or so related to each other geographically, as to admit of its production, not merely within reasonable limits of cost, but on any terms whatever.

The position of the coal measures of the United States suggests the idea of a gigantic bowl filled with treasure, the outer rim of which skirts along the Atlantic to the Gulf of Mexico, and thence returning by the plains which lie at the eastern base of the Rocky mountains, passes by the great lakes to the place of beginning, on the borders of Pennsylvania and New York. The rim of this basin is filled with exhaustless stores of iron ore of every variety, and of the best quality. In seeking the natural channels of water communication, whether on the north, east, south or west, the coal must cut this metalliferous rim, and, in its turn, the iron ores may be carried back to the coal, to be used in conjunction with the carboniferous ores, which are quite as abundant in the United States as they are in England, but hitherto have been left unwrought, in consequence of the cheaper rate of procuring the richer ores from the rim of the basin. Along the Atlantic slope, in the highland range from the borders of the Hudson river to the State of Georgia, a distance of 1,000 miles, is found the great magnetic range, traversing seven entire States in its length and course. Parallel with this, in the great limestone

valley which lies along the margin of the coal field, are the brown hematites, in such quantities at some points, especially in Virginia, Tennessee, and Alabama, as fairly to stagger the imagination. And, finally, in the coal basin is a stratum of red fossiliferous ore, beginning in a comparatively thin seam in the State of New York, and terminating in the State of Alabama, in a bed of 15 feet in thickness, over which the horseman may ride for more than 100 miles. Beneath this bed, but still above water level, are to be found the coal seams, exposed upon mountain sides, whose flanks are covered with magnificent timber, available either for mining purposes or the manufacture of charcoal iron. Passing westward, in Arkansas and Missouri, is reached that wonderful range of red oxide of iron, which, in mountains rising hundreds of feet above the surface, or in beds beneath the soil, culminates at Lake Superior in deposits of ore which excite the wonder of all beholders; and returning thence to the Atlantic slope, in the Adirondacks of New York, is a vast undeveloped region, watered by rivers whose beds are of iron, and traversed by mountains whose foundations are laid upon the same material; while in and among the coal beds themselves are found scattered deposits of hematite and fossiliferous ores, which, by their proximity to the coal, have inaugurated the iron industry of our day. Upon these vast treasures the world may draw its supply for centuries to come, and with these the inquirer may rest contented, without further question, for all the coal of the rest of the world might be deposited within this iron rim, and its square miles would not occupy one-quarter of the coal area of the United States.

With such vast possessions of raw material, we are naturally brought to the consideration of the elements which enter into the cost of producing iron in the United States, as compared with the other iron-producing countries of the world. And first, the distinction must be drawn between the cost determined by the quantity of labor expended in the production of a ton of iron, and the cost in money as determined by the price paid for the labor. The former is the absolute and natural cost, and is the only just standard of comparison between nations, if national wealth is defined to be the amount of capital in existence, plus the amount of labor available for production. The other is the artificial or accidental cost, of which, indeed, we may take advantage in our buying or selling, but forming no just standard of comparison in estimating the relative cost of production in different countries. There is a difference, familiar to all in the United States, between the cost of articles measured by gold or by currency, which makes it, for the time, easy to understand the difference in cost measured by money or by day's labor.

England, having the largest and most accessible stores of coal and iron ore, can produce a ton of iron with less labor than any other European nation; and hence it will be most profitable to institute the comparison of cost measured by labor, first, with Great Britain. In the Cleveland region, which is most favorably situated for the cheap production of iron,

the cost of producing a ton of pig iron is about 40 shillings, which, at the average rate of wages paid around the blast furnace, is equivalent to 11 days' labor—that is to say, the labor of 11 men for one day. It is possible that in one or two works this may be reduced to 10 days, but in others it rises to 12 or 13. In the United States, the cheapest region for the manufacture of pig iron, as yet extensively developed, is on the Lehigh river, in the State of Pennsylvania, where, taking coal and ore at their actual cost of mining, pig iron is produced at an average cost of $24 per ton, which represents, at the present rate of wages, the labor of about 13 days. But when the iron business is established along the great valley which extends from Virginia to Alabama, the labor of bringing the coal and ore together will be considerably less than on the Lehigh river, and it is safe to say that there iron can be made in any required quantity, when the avenues of communication are sufficiently opened, with as little labor, to say the least, as it can be produced in the Cleveland region. In France, Belgium, and Prussia, each now requiring a larger expenditure of human labor to produce a ton of iron than is required in England, there are no such possibilities of reduction, because every year their ore is becoming more expensive, and the cost of mining coal will increase more rapidly than in England, in consequence of the size and character of the veins. Hence follows the deduction that, if France, Belgium, and Germany, are to compete with England in the open markets of the world, the competition can only be maintained by the payment to labor of a lower rate of wages; or, to state it in another form, the greater the natural advantages possessed by a country for the production of iron, the larger will be the rate of wages paid to the workman; and this is found to be verified by existing facts.

From the statement published by Schneider & Co., at Le Creusot, it appears that the average rate of wages paid in 1866 was as follows:

	Francs.
Ore miners	3.33
Coal miners	3.25
Blast furnaces	2.95
Rolling mill	3.83
Machine shops	3.40
Miscellaneous	3.03

And the average price paid for the whole of the 10,000 workmen employed at this great establishment was 3.45 francs per day.

Unfortunately the rates paid for the specific branches of work are not specified, but at the iron works at Sireuil this information has been procured in detail:

	Francs per day.
Common laborers	2.50
Puddlers	8.00
Puddlers' helpers	2.50
Puddle rollers	5.00

	Francs per day.
Shinglers	5.00
Heaters	7.00
Heaters' helpers	2.50
Finishing rollers	6 to 7
Machinists	3 to 3.50
Blacksmiths	....
Masons	5.00

In South Staffordshire, in 1866, the following rates were paid, as shown by the official returns published by the government:

	Per day.				
Common laborers	2*s.*	6*d.*	to	3*s.*	0*d.*
Puddlers	7	6	to	7	10
Puddlers' helpers	2	6	to	2	11
Puddle rollers	9	0			
Heaters	7	0			
Heaters' helpers	3	6			
Finishing rollers	11	0			
Shinglers	9	0	to	15	0
Machinists	4	0	to	16	0
Blacksmiths	4	0	to	5	0
Masons	7	6	to	8	6

A comparison of these two tables will show that, for every franc paid in France, there is more than a shilling paid in England, and this corresponds with the general statement made by M. Schneider to me at Le Creusot. Assuming a little more than a shilling to the franc, 3*s.* 6*d.* per day would appear to be the average rate of wages paid in England for labor in iron works of all kinds, skilled and unskilled, and in no part of England does it exceed 4*s.*

In Belgium, according to Creed & Williams, in the coal mines the following wages are paid:

	Per day.				
Common laborers	1*s.*	6*d.*	to	2*s.*	6*d.*
Loaders of coal	2	6	to	2	11
Wood cutters	2	6	to	2	11
Wood or tree setters	3	1	to	5	0
Miners	2	11	to	4	2
Exceptional men	5	0	to	6	0
At the blast furnaces:					
Fillers	1	1	to	2	1
Box fillers	1	4	to	1	8
Common laborers	1	5	to	1	8
Furnace keepers	2	1	to	2	11
In the rolling mill:					
Puddlers	4	2	to	5	0
Helpers	2	3	to	3	1

	Per day.
Rollers	4s. 2d. to 5s. 10d.
Helpers	3 4 to 4 2
Shearers	1 10 to 2 6
Common laborers	1 5 to 2 1

A comparison of these tables shows that the rate of wages is higher in Great Britain than in Belgium, and in France, being certainly in the order, and probably nearly in the ratio, of the natural advantages of these countries for the production of iron; and this view is confirmed by the selling price of iron in the respective countries, at the present time, when it is admitted on all hands that there is no profit to the maker.

The price of merchant bar-iron, at the works—

In England, is	£6 10 per ton.
In France	8 0 (200 francs) per ton.
In Belgium	7 0 (175 francs) per ton.

The difference between the cost of French iron and Belgian and English, aside from cost of transportation, which is very light, is compensated by the import duty, which, on iron from England and Belgium, amounts to sixty francs per ton. Independently of this tariff, which admits of a considerable importation of iron into France, it would not be possible for the iron business to be continued on any considerable scale, for the reason, as will be seen, that the wages are already at the lowest possible point consistent with the maintenance of human life in a condition fit for labor; the average earnings of all the workmen, skilled and unskilled, employed in an iron work being at the rate of 3.45 francs per day, or about 66 cents per day in gold; the great mass, however, of common labor receiving less than 50 cents per day in gold. In order to estimate the purchasing power of this sum, it is necessary to give the prices of the principal articles required for the support of life, and for this purpose I have selected the department in which Le Creusot is situated, as the proper locality for comparison, with the rate of wages there paid:

Wheat bread	0.25 francs per lb., equal to 5 cents in gold.
Rye bread	0.20 francs per lb., equal to 4 cents in gold.
Beef	0.65 francs per lb., equal to 13 cents in gold.
Mutton	0.75 francs per lb., equal to 15 cents in gold.
Veal	0.75 francs per lb., equal to 15 cents in gold.
Pork	0.75 francs per lb., equal to 15 cents in gold.
Chickens	1.00 to 2.50 francs, equal to 20 to 50 cents in gold.
Geese	3.00 francs, equal to 60 cents in gold.
Ducks	1.50 to 2.00 francs, equal to 30 to 40 cents in gold.
Butter	1.00 francs per lb., equal to 20 cents in gold.
Dozen eggs	0.50 to 1.00 francs, equal to 10 to 20 cents in gold.
Potatoes	0.50 francs per décalitre, equal to 40 cents per bushel.
Ordinary wine	0.40 francs per litre, equal to 5 cents per pint.
Beer	0.25 francs per litre, equal to 3 cents per pint.

House rent is cheap; a small, ordinary, but comfortable house, with a garden, renting for $16 per year in gold. Clothes are also cheap, costing not more than half the price of similar articles in the United States; but fuel is rather dearer on the average. It does not require any very extensive observation in order to verify the obvious conclusion deducible from the above figures, that the general condition of the working classes in France, from a material point of view at least, is simply deplorable. It requires the utmost economy on the part of a laboring man, and the united labor of his wife and his children, to keep his family in existence; and it is the accepted rule and practice for such a family to have meat but once a week; and any change in this condition of affairs, involving a change in the remuneration paid to the common laborer, would put it out of the power of the iron-masters of France to carry on their business, in competition with Belgium and England, in the absence of a higher tariff on imports. The existence of the iron business in France, therefore, as a national branch of industry, may be said to rest upon the elementary condition of giving meat once a week only to the great mass of laborers who are engaged in its production.

In Belgium, substantially the same state of affairs prevails. In the despatch of Lord Howard de Walden, the British minister at Brussels, to Lord Stanley, dated February 11, 1867, on the subject of Belgian industry, he says: "The characteristics of the Belgian workmen are steadiness and perseverance, combined with great intelligence in working after models; their habits are not so expensive as those of English artificers; their diet is more humble, they consume less meat, and their bread is seldom purely wheaten or white in quality; rye, and the cheaper quality of wheat called '*épeautre*,' enter in great proportion into the composition of the loaf; beer and spirits are both lower in price than in England; they seldom use tea, and the chiccory root constitutes a very economical and wholesome substitute for coffee. * * * * The system of schools for infants from two to seven years, and from seven to twelve years, is very general, and affords great facilities—the children being cared for—to both their parents to occupy themselves in daily service, and by combined industry to ameliorate the condition of their family. In all these respects, therefore, the necessaries of life being the base of wages, the Belgian enjoys advantages over the British workman."

From our American point of view, these "advantages over the British workman" in dispensing with meat and tea, and in substituting chiccory for coffee, and in appropriating the labor of both parents for a mere existence, are not so apparent. But we are naturally brought by it to consider the condition of the British laborer.

It has been seen that the natural advantages of Great Britain, in the possession of its vast stores of coal, afford a fund for the payment of better wages to the laborer in England than on the continent, and the British workman has not been slow to assert his rights to all he can get, and his physical condition is undoubtedly superior to that of his French

and Belgian neighbors. If he is not better lodged, he is at least better fed, and in the iron works it is probable that the workmen generally get meat once a day. But, as a general rule, the labor of the women and children is required in order to eke out the subsistence of the family. In Wales women are extensively employed in the works, doing the labor for which a man would be required in America, and earning from ten pence to one shilling three pence per day, or rather less than half the wages that would be paid to a man for the same labor, which they perform equally well. In Staffordshire, and in the north of England, and in Scotland, women and children are still extensively employed above ground about the mines, and around the coal heaps at the mouths of the pits, the substantial result of which is that the labor of the whole family is procured for the sum which would be paid to its male head, if he alone labored for the support of the family, of course at a far lower cost in the resulting production of iron than would otherwise be possible. Restraining laws have been enacted in England of late years in regard to women and children, limiting the number of hours during which they may be employed, and also providing that they shall not be employed during the night, except in certain specified cases. But if the women and children were altogether withdrawn from those occupations, as they are in the United States, it would not be possible to produce iron, except at a considerable advance on its present cost.

Passing from the material to the intellectual condition of the workmen in France and England, the provision for the education of the children is upon a very limited scale indeed, and although there are creditable exceptions in particular localities, mainly due to the enlightened conscience of the proprietors, the great mass of the working classes out of the large cities are deplorably illiterate. In the department of Saône et Loire, where the works of Le Creusot are situated, and where the most commendable efforts are being made by Messrs. Schneider & Co. to educate the rising generation, it appears that 36.19 per cent. of those who were joined in marriage in 1866 could not write their names, and of the conscripts drawn for the army from the same department, in the same year, 24.51 per cent. were unable to read. And the same statistics show that, taken as a whole, in nearly two-thirds of France the number of those who cannot write their names on marriage is between the limits of thirty and seventy-five per cent. of the total number. This deplorable state of affairs has, of late, led to the establishment of schools for the instruction of adults, mostly voluntary, upon which there were in attendance during the present year 829,555 adults, of whom 747,002 were men and 82,553 were women. Of 110,503 who could neither read nor write on entering the course in October, 1866, 87,211 had learned to read by the 1st of April, 1867; 12,632 instrnctors have given their services gratuitously, and the whole movement, and the statistics above given, prove both the depth of ignorance into which the working classes have been plunged, and their earnest desire to emerge from it.

Surprise may be expressed that in view of the inadequate reward for labor in France, there has not been a larger emigration to our own country, where labor is so much better paid. The difficulties arising from the difference in language would of themselves be a great impediment to any extensive emigration movement; but there are impediments of another kind, not generally understood, which tend to prevent any relief to the laboring classes from this source. The law of "livret," as it is called, is peculiar to France. By its terms every workman is compelled to obtain from the police a kind of pass-book or register, in which his name, age, and occupation are inserted, and which he must show to an employer before being taken into his service, and no employer is permitted to receive into his works any workmen upon whose "livret" is not indorsed a full discharge from his previous employer. Provision is also made for the indorsement upon the livret of any indebtedness which may be due from the workman to the employer, and his debt therefore follows the workman as a mortgage upon his labor from place to place. Although in express terms there is nothing in the law which would warrant the employer in withholding an indorsement on the livret, yet in practice it is a restraint on his freedom of action to such an extent that workmen employed in the large works usually remain there permanently, so that there is but little change, and no opportunity whatever for practical combination in strikes and turnouts. The whole of this system is so peculiar, and throws so much light upon the power it gives to produce iron at a cost which would not be possible if the workman were a free agent, that I have deemed it best to annex to this report in an appendix (G) a translation of a circular which was obtained from the prefecture of police.

The moral condition of men is so dependent upon their physical and mental status that it is probably unnecessary for me to enlarge upon the obvious conclusions that might be inferred from the facts above recorded; but the conviction in my own mind was so profound, after a very careful survey of the whole field, that I deemed it my duty to accept an invitation to testify before the Trades Union Commission in England, in the hope that a full discussion of the physical and moral elements involved in the organization of industry would result in the ultimate elevation of the working classes of Europe to such a standard, at least, as would render the conditions of competition between our own country and Europe more just and equitable. It is quite evident that in the effort to produce cheap commodities, and to undersell each other in the markets of the world, the rightful claims of humanity have been disregarded to such an extent that the reorganization of labor, in its relation to capital, is felt by all thoughtful men to be an imperative necessity.

It cannot be that the aim of society is only to produce riches. There must be moral limits within which the production of wealth is to be carried on, and these limits have been and are being so obviously transgressed that a spirit of discontent pervades the entire industrial world; and in the very countries where this competition has been pressed to its

utmost limits capital has ceased to become remunerative, although humanity itself has been sacrificed to its demands. The evidence which I gave before the Trades Union Commission was delivered in this spirit of deep concern for the welfare of the working classes; and inasmuch as a few incidental sentences repeating statements which had been made to me in regard to the Pittsburg strike, but of no consequence in reference to the main question, were seized upon by the London Times as a groundwork for characteristic unfavorable comment on American institutions, and some feeling was excited among the working men in the United States in reference to these misrepresentations, against which, it will be seen, I took occasion to protest on my second hearing before the commissioners,[1] long in advance of any knowledge on my part of the effect produced by them at home, it is deemed proper to state that the evidence so given, in Europe at least, was universally regarded as an appeal in behalf of the working classes, not in defence of any violation on their part of the fundamental principles of social science, but in assertion of their just rights to education, domestic happiness, and adequate remuneration for labor.

There are some statements made thereon, of no great importance in themselves, based upon information derived from other parties, on whom I had reason to rely, which may have been erroneous; but in all such cases, where I did not speak of my own knowledge, I expressly so stated, and this was particularly the case in regard to the Pittsburg strike, where the evidence shows that I expressly disclaimed personal knowledge of the facts; but I desire now to state that the information was derived from a resident of Pittsburg in whom I had reason to feel entire confidence. In my second evidence before the commission, it will be seen[2] that I took occasion to correct some errors of this kind, having in the mean time received more correct information. There are also some replies bearing on the nationality of workmen, elicited in answer to questions over which I had no control; but in so far as they may appear to be invidious to any one nation, there is no real cause for complaint when the answer is understood. For example, the statement that the Irish are rarely first-class puddlers was made as a matter of fact in nowise depending on the land of their birth, but because they do not begin to learn the business until they arrive in America, full-grown adults, whereas in England the education of the puddler begins in boyhood, and is pursued for many years before he takes a furnace. The same answer would, therefore, have been given to the same question, if asked with reference to the natives of any other country who had not learned the business from boyhood.

But if, in comparison with the ample provision made in our country for the education of the masses, the arrangements in France and England are upon a meagre scale, the opportunities for scientific and technical

[1] See Appendix H. [2] Ibid.

instruction, in France especially, are of a far more complete and generous character. For the governing classes, or for those who, rising out of the lower ranks, are educated to fill positions of trust and responsibility, there exists a series of educational establishments of so thorough a course in their respective departments as to exhaust all that experience and science can do for the preparation of engineers and conductors of industry. The Ecole Centrale des Arts et Manufactures at Paris, the Conservatoire Impériale des Arts et Métiers, several large agricultural schools, L'Ecole Impériale des Ponts et Chausées, L'Ecole Impériale des Mines, L'Ecole Impériale de Commerce à Paris, the three schools des Arts et Métiers at Chalons, Aix, and Angiers, the School of Mines at St. Etienne, the School of Watchmaking at Cluses, of the Mining Classes at Alais, the Naval School at Marseilles, are all sustained by the government in the interests of industry and commerce, and give to French industry that intelligence, science, and skill, which, in the Exposition, extorted universal admiration, and the general confession that its products, even in machinery and metals, were up to the highest standard of excellence. Similar schools in the United States ought to be the fruit of the great endowment of lands given to the States by Congress for the establishment of institutions designed to teach mechanical and agricultural science and art; but it is to be regretted that, at the present time, the application of this grant has not been so directed as to secure such a result, and we must console ourselves with the reflection that, if we are deficient in the higher education necessary for the best industrial development, we have in a measure supplied its place by a general diffusion of knowledge, which, evoking the ingenuity and individuality of each workman, has rendered it less necessary than in countries where the masses are in ignorance. But it cannot be disputed that this individuality and ingenuity in our American character will be more valuable and powerful when directed by the highest order of intelligence and thoroughly trained scientific leaders.

It is obvious that the abnormal rates for labor which we have been considering cannot prevail in any one branch of industry alone, but must extend to all, as labor, like water, must seek a general level in each community governed by the same laws and subjected to the same influences. All articles of commerce are, therefore, produced below their normal cost—that is, the cost which would be possible if the fundamental laws of humanity were not violated in the employment of women and children, and the payment of a rate of wages to the common laborer inadequate for the proper support and culture of the family. In those commodities which require in the United States more human labor for their production than is necessary in Europe, where labor is so inadequately paid, we have, perhaps, no other interest than a general concern in the welfare of the human race; but so far as iron is concerned, from the fact that we can produce it with as little consumption of human labor as any other nation in the world, the case is different, because there is no absolute loss of wealth, and no misapplied power in its production; and the

only question to be discussed is, whether it shall be taken out of the general category of manufactures not so favorably placed as to the cost of production, and by positive legislation placed in the same condition as it would have occupied with reference to foreign competition, if the rate of wages in other countries had never been reduced below their normal standard.

We have seen that the cost of making iron in England, Belgium, and France, at the present time, varies from £6 10*s*. to £8 per ton, and £1 additional suffices to pay its cost of transportation to the seaboard of the United States. At these ports American iron cannot possibly be delivered at a less cost than $60 in gold against $40 in gold for the foreign article, and the entire difference consists in the higher wages, and not larger quantity of labor required for its production in the United States, where the physical, mental, and moral condition of the working classes occupy a totally different standard from their European confreres, and where the wages cannot be reduced without violating our sense of the just demands of human nature.

At the same time it is to be observed that the business is so far overdone in Europe that no profit can be realized by the capitalist, except in special cases, for which adequate reasons can be given. The actual remedy for this over-production would be to withdraw the women and children, as we do, from this class of industry, whereby the production must be reduced, the rate of wages raised, the cost and the selling price increased, capital become remunerative, and the ability to procure iron, made cheap by its adulteration with the violated laws of humanity, be forever extinguished. To what result the general discussion which this subject is now receiving in Europe will lead it is not easy to decide; but it is a curious phenomenon to listen in France to the loud complaints which are made against the competition of Belgium in the manufacture of iron, and stranger still in England to the same complaint, and the broad declaration that it will not be possible to do anything for the education and elevation of the working classes without exposing their manufacturers to ruin in consequence of the competition with the worse paid and worse fed labor of Belgium. The truth is that the whole system is false, and now, when pressed by the energy, enterprise, and competition of the age to its legitimate results, humanity is in rebellion, and there is a general cry from all classes, laborers, employers, philanthropists, philosophers, and statesmen, alike for relief.

The necessity for this relief becomes painfully apparent when the poor-law returns made in England are carefully examined, from which it is evident that there is an army of paupers pressing upon the occupations of the common laborer, and striving to push him over the almost insensible line which divides these two classes from each other. It is not possible that the laborer should receive more than bare subsistence wages, and there can be no relief for his patient suffering, so long as there are thousands who, unable to earn any wages at all, stand ready

to fill up every gap in the ranks of industry; and to the honest laborer himself, standing on the edge of this line, over which he is liable at any moment to be forced into the ranks of pauperism, the anxiety and miserable state of uncertainty for himself and his family must be fatal to all rational happiness, and is well calculated to drive him into vicious indulgences and temporary excesses whenever a transient opportunity is afforded, as a momentary relief from a condition of hopeless misery.

From the returns made to the British Parliament as to pauperism in the month of September, A. D. 1867, it appears that out of a population of 19,886,104, dwelling in the area for which the returns are made, 872,620 persons were on the list of paupers, supported by public charity, of which number 129,689 were in the workhouses, and 738,726 were relieved in their own houses. This latter portion constitutes the army which substantially regulates the rate of wages for labor, as they are ready, to a greater or less extent, to take any vacant place which may offer itself. And this state of the case exists not in mid-winter, but just after the close of the harvest, and the returns show that the evil is an advancing one, as there is an increase of 27,521, or 3.3 per cent., in 1867 over the corresponding week in 1866. And a study of the tables which are hereunto annexed (Appendix I) shows the largest rate of pauperism is in the manufacturing and not in the agricultural districts.

By another parliamentary return, which is also annexed, (Appendix I,) it appears that the average number of scholars attendant upon the schools under government inspection in the year 1866 was 871,309 in England and Wales, showing this suggestive fact, that the paupers receiving public relief, and the children receiving instruction in schools aided by the public funds, were about equal in number. This statement alone, if other evidence were lacking, would serve to prove that the working classes of Great Britain have not yet achieved the position in point of education and social comfort to which humanity is entitled. Nor can it be alleged that this is due to any deficiency in the resources provided by nature for the reward of industry. The coal and iron ore mines of England afford the most magnificent fund to be found on the face of the globe for the abundant remuneration of the capital and labor engaged in their development, and every class in the community, except the operatives themselves, have enjoyed a bountiful return for their interest in this national endowment. The landowner has been largely paid, not only by the royalties derived from the minerals, but in the enormous increase in the value of the soil by the rapid growth of population engaged directly and indirectly in the manufactures based on their consumption. The capital invested in manufactures in Great Britain has, in the main, reaped a most abundant reward, and the general result has been an accumulation of capital in the hands of the higher and middle classes unequalled in the history of mankind.

That the working classes have not been equally well rewarded is due simply to the improvident and even reckless manner in which these

great natural resources have been employed, giving rise to a competition unlimited by any other consideration than the immediate profit to be derived by the capital invested in the business. Of course, the less the rate of wages, the longer the number of hours of work to be got from the laborer, the greater the number of women and children that could be employed, the lower will be the cost of the product, and the more decided the ability to undersell all foreign competitors in the markets of the world. Hence, in the absence of restraining laws and an enlightened conscience on the part of the operators and manufacturers, and in the presence of a large population in a restricted area, governed in the interests of special classes, it was inevitable that the superior natural resources of Great Britain should be used, as they have been, rather to crush out foreign competition than to elevate the working classes; and this very attempt to undersell foreign nations in their own markets necessarily involved the lowest possible rate of wages in those countries consistent with mere existence; reacting, in turn, upon the English labor market, and compelling lower rates of wages than would otherwise have been required, if the aim of the nation had been directed to the payment of the largest possible compensation to its own working classes, rather than to the control of the markets of the world even at the expense of humanity itself.

The possession of these wonderful deposits of coal and iron, as a fund for the payment of adequate wages to labor in Great Britain, is equivalent to our virgin soil in the United States, enabling both nations to pay the highest possible rate of wages consistent with the conservation of capital; but this advantage in Great Britain has been deliberately and recklessly thrown away by a competition between the English manufacturers themselves, resulting in an over-production, and compelling a steady pressure upon the wages of labor, in order to keep up the production and secure larger consumption by lower prices for the commodities. It is a mistake to suppose that this reduction in price has been caused by the competition of foreign nations with Great Britain, for we have seen that France cannot produce enough iron for its own consumption, and that Belgium only turns out one-tenth as much iron as Great Britain, and is therefore governed as to price solely by the rate at which Great Britain is willing and able to furnish the remaining nine-tenths. If it were possible for Belgium to alter the ratio of production, she might in the long run make the price for the total product; but it is simply ridiculous to apprehend, in view of the natural resources of the two countries, that any such change can ever be effected.

The most interesting industrial and social question of the age is, therefore, the policy which will be pursued by Great Britain in the administration of its mines of coal and iron. And the royal commission, now making an official inquiry into the exhaustion of the coal fields, will stop far short of the real scope of the question if it fails to investigate whether, by wise and suitable regulations, the annual product of coal

cannot be so regulated as to secure a far better remuneration to the labor engaged in its production than it has heretofore received. I am perfectly aware that such regulations must necessarily be restrictive in their character, and, at the first glance, will appear to be at war with the commercial policy of free trade advocated in Great Britain. Very little reflection, however, is required to show that by far the greater portion of the legislation of all enlightened nations is necessarily of a protective and restrictive character; and at this day no enlightened statesman would advocate the deliberate sacrifice of local advantages for the sake of any mere abstract theory, which might be ever so well founded in reason, but fails to be applicable in the presence of exceptionable facts and resources. The protection of life, liberty, property, and social order, the title to lands and personal property, rest entirely upon protective laws; and all provisions for the protection of capital and health and the establishment of police are so many restraints upon the natural freedom of the individual; and surely legislation looking to the wisest possible use of national resources and the prevention of the waste or misapplication of the raw material, upon which the structure of the national industry and prosperity and the welfare of the working classes rest, is not merely a natural but a necessary step in the progress of industry and the development of civilization.

In no country in the world are so many proofs of the wisdom of this course to be found as in the history of British legislation in reference to the working classes during the last 35 years. The repeal of the corn laws was a measure of eminent protection to the working classes, relieving them of the taxes imposed upon food for the benefit of the landowner alone; because the condition of the agricultural laborer could not be made worse, but could only be improved by any change. The series of laws regulating the employment of women and children in factories and mines are not merely highly restrictive, but by common consent have produced the happiest results on the moral and physical condition of the working classes. The laws recognizing the legal existence of friendly societies; for the encouragement of building associations; the conversion of the post offices into savings banks for the working classes; for the granting of annuities and life assurance guaranteed by the government to the working classes, on the payment of small periodical instalments; for the encouragement of co-operative stores and associations; for "partnerships of industry," in which the workman is allowed to have an interest in the profits of the business without becoming liable as a partner for the debts; the statutes authorizing the establishment of free reading rooms, libraries, and museums, by a vote of the rate-payers in any borough, town, or city, constitute a course of wise legislation unmistakably protective, restrictive, and enabling; persistently advocated and successfully established by the most sagacious, liberal, and philanthropic statesmen of the present age, and resulting in so marked an improvement in the condition of the working classes, accompanied

with so decided an advance in the rate of wages, that it is scarcely possible longer to deny, that the first step towards securing to the working classes an adequate reward for their labor is such legislation as protects them from the evils which seem to be inseparable from the spirit of unrestrained competition between nations and between men, which experience has shown to result in the utter disregard of the moral and physical condition and social welfare of the working classes, unless regulated by positive legal enactment.[1]

This wise course of legislation may be said to be but fairly initiated in England, but the intelligent observer cannot fail to be convinced that it will be persisted in until all special privileges which interfere with the normal distribution of the proceeds of labor and capital will be removed. The effect will undoubtedly be a rise in wages, already apparent; and this result is unquestionably a matter of deep concern to the manufacturers and capitalists of Great Britain, who fear that it will deprive them of their ability to control the markets of the world, as they now do, with the products of their mills. But there is in reality no just ground for this apprehension. The distribution between capital and labor may, and must, undoubtedly, be changed, but the aggregate income will not on the average of years be reduced, because the control of the fuel of the world, that is to say, of the condensed power which has been stored up by Divine Providence for its use, is in the hands of the Anglo-Saxon race in Europe and America, who alone have reduced prices by a competition with other nations, impossible but for the possession of the mineral fuel in such vast quantities, and for the violation of the natural laws which should govern the employment and compensation of labor. The transition to a more equitable basis of production will simply enable other countries, who, as we have seen, cannot do more than supply themselves with coal and iron, to raise their laboring classes out of a condition still more deplorable than exists in England, without by any possibility enabling them to keep up any effective competition in the markets of the world, for the supply of the iron required for the future progress, development, and civilization of mankind. A rise in wages in England, therefore, will not only be a blessing to the workmen of that favored country, relieving it of pauperism, so far as it may be possible to extinguish poverty at all, but will be a harbinger of light to the unpaid, unfed, and unhappy operatives throughout all lands in which human industry is now weighed down by the effects of British competition, based upon superior natural resources. And to me it is a suggestive, and for humanity an encouraging fact, that the agitation and restlessness which characterize the working classes of our age are mostly apparent in Great Britain and the United States, who are not only so far in advance of all

[1] Readers desirous to investigate the effect of protective, restrictive and enabling legislation on the condition of the working classes, are referred to the very able treatise on "The Progress of the Working Classes, 1832–1867," by I. M. Ludlow and Lloyd Jones, published by Alexander Strahan, London, 1867.

other countries in the possession of natural industrial resources, but who, from the habit of free discussion and prompt obedience to the popular voice, (the result of constitutional government long in force,) will be most ready to accept the conclusions deduced by the stern logic of experience and facts, and modify their legislation so as to conform to the just demands of humanity whenever the proper course is discovered and made plain to the common sense of the people.

When, by reason of such legislation, the wages of labor in Great Britain have reached their normal condition, there will no longer be any occasion for us to consider the question of protective or prohibitory tariffs; but in the mean time, to the people of the United States, who, in consequence of the possession of virgin soil, have in comparison with their European neighbors suffered but little from violations of the fundamental principles of social science, two courses are open. We can either take advantage of the unnaturally cheap rate at which our wants can and will be supplied from abroad, while the present system lasts, and, by throwing open our ports to foreign iron, purchase foreign labor at a far lower rate than we are willing to sell our own, and thus abandon a business which, so long as our present rates of wages are maintained, cannot be conducted in the United States even without profit; or we can impose such a duty on foreign iron as will make up for the difference in the amount of wages paid for making a ton of iron in Europe or in this country, less the expense of transportation.

The decision of this question is mainly of interest to the working classes themselves, and to the great body of the farmers, because if the iron business is abandoned for the present in the United States, the labor now employed in it must in the main take to the soil, and a larger yield of agricultural products be insured. The surplus so produced must seek its market in the open marts of the world, and the mouths that would have been fed on this side of the Atlantic will simply be fed elsewhere, although not so abundantly and so generously. But it must be remembered that whatever may be the price of bread in Europe at the works where the iron will be made, would be the price which the same operatives could afford to pay if the iron works had been placed where the grain is grown, and that the cost of transportation thence is just so much deducted from the price which the farmer would have received if the grain had been consumed at home.

The question is one, also, which more concerns the west than the east, because the loss caused by transportation from the west is greater; and the final decision of this great question should therefore be well considered, especially with reference to the point whether the saving produced by the purchase of cheap iron and other articles will compensate for the loss entailed by the transportation of the grain.

It forms no part of the purpose of this report to deduce any conclusion on this subject, but only to state the facts in such form as will enable intelligent legislation to be enacted, keeping in view the interests of all

classes, and above all the considerations of independence, essential to the dignity of the American republic and the welfare of mankind. But in the discussion of this question, and in the legislation which may be proposed to meet the best interests of the nation, in regard to a supply of iron and steel, the broad distinction which exists between the nature of the question in Europe and the United States must never be lost sight of. On the continent, protective duties on iron are imposed in order to counterbalance the superior natural resources and advantages of Great Britain for the production of iron, and not to secure higher wages to the laborer; whereas, in the United States, protective duties, if imposed at all, are not necessary because our natural advantages for making iron are inferior in any particular to those of Great Britain, but simply because the wages of labor are fixed upon a most just and liberal scale to the workmen in the first instance, and by the law of equivalents to the whole industrial force engaged in the great work of production, of whatever form and nature.

If the facts and suggestions contained in this report, the result of half a year of careful study of the Exposition, and the knowledge which it enabled me to acquire in reference to the social condition of the working classes in Europe, shall in any way aid Congress in arriving at a judicious solution of these grave questions, involving so many and such varied interests, and if, as I hope, the terrible evils of pauperism shall be even for a time, and possibly forever, averted from our own country by legislation based upon sound, social, and economical principles, I shall cease to regret the strange and cruel misrepresentations to which I have been subjected among the working classes, in whose behalf mainly the duty confided to me was undertaken.

Whatever policy may be finally adopted with reference to American industry, it is a source of profound satisfaction, and should be a subject of general congratulation, that a careful survey of the natural resources of those nations who stand in the van of European progress and civilization justifies the declaration that the great problem of democratic institutions is being solved in a land having, in addition to a fruitful soil, the largest and best supplies of the fundamental elements upon which industry, progress, and civilization are based; and that there is good reason to hope that here it may be shown how wealth may be created without the degradation of any class which labors for its production; the only advantage (if advantage it may be termed) possessed by Europe over the United States, for the cheap production of iron and steel, being in the lower and inadequate rate of wages which there prevails, and not in any superior natural resources in ore, fuel, or geographical position.

ABRAM S. HEWITT,

United States Commissioner to the Universal Exposition of 1867.

Hon. WILLIAM H. SEWARD,

Secretary of State.

PARIS, *November* 30, 1867.

SECTION II.

BESSEMER STEEL.

THE BESSEMER PROCESS IN VARIOUS COUNTRIES.

The undersigned has the honor to submit a special report upon "Bessemer steel," prepared under his direction by Frederick J. Slade, scientific assistant to Committee No. 6, and duly approved by the committee and ordered to be laid before the Commission.

ABRAM S. HEWITT,
U. S. Commissioner and Chairman of Committee No. 6.

PARIS, *June* 22, 1867.

The Paris Exposition affords valuable information in reference to the capabilities of the Bessemer process for the production of all grades of metal, from a near approach to wrought iron to the hardest and finest kinds of steel. A comparison of the specimens sent from the various countries shows that the quality of the metal produced depends chiefly upon the nature of the raw materials used, and accordingly it is only in those countries where the very best ores and purest coals are employed that we find the finer grades of steel produced.

It will, perhaps, be most instructive, therefore, to examine the manner in which this process is conducted in each country separately, and to trace, if possible, the relation between the nature of the finished products and the materials and modes of working employed in their manufacture. We begin naturally with

ENGLAND.

The iron almost exclusively employed in England for the pneumatic process is obtained from the Cumberland district, and is derived from red hematite ores. Dr. Percy, in his well-known work on metallurgy, gives as the analysis of two specimens of these ores:

	I.	II.
Sesquioxide of iron	95.16	90.36
Protoxide of manganese	0.24	0.10
Alumina	.....	0.37
Lime	0.07	0.71
Magnesia	.....	0.06
Phosphoric acid	trace.	trace.
Sulphuric acid	trace.	trace.

	I.	II.
Bisulphide of iron	trace.	0.06
Ignited insoluble residue	5.68	8.54
	101.15	100.26
Silica	5.66	7.05
Alumina	0.06	1.06
Sesquioxide of iron	.....	0.19
Lime	.....	trace.
	5.72	8.30
Iron, total amount	66.60	63.25

The blast furnaces in which these ores are smelted average about 50 feet in height and 15 feet diameter of boshes, and are in most cases open-topped, the opinion among the iron masters being that the quality of the iron is injured by any attempt to draw off the gas. At some furnaces, however, this notion is abrogated, and the waste gases are utilized for heating the blast. Among these are the furnaces of the Barrow Hematite Iron and Steel Company, the West Cumberland, and the Wigan Iron and Coal Company's furnaces. The quality of pig produced at these latter works does not perhaps stand invariably as high as that of the Whitehaven Hematite Iron Company, (Cleator,) the Workington Iron Company, or the Harrington, but if there is a difference it is easily accounted for by the quality of the materials used, without the necessity of resort to the supposition of an injurious effect from utilizing the escaping gas.

The fuel used at the furnaces in the Cumberland district is the best Newcastle coke, which is remarkable for its hardness and freedom from sulphur. Dr. Percy gives the percentage of sulphur as 0.8 and of ash 4.45. No charcoal pig is made in England for the Bessemer process. The fluxes employed are a limestone quite free from phosphorus, and a portion of black shale from the coal beds, consisting of clay and carbonaceous matter, without any appreciable amount of sulphur. The percentage of iron indicated by the above analysis, viz., from 60 to 70, appears to be a fair average, and the ores are not calcined. As it is necessary that the iron should be as gray as possible, not less than 30 hundred-weight of coke are used per ton of iron produced, and a charge is about 50 hours in coming down through a furnace of the dimensions given above. The yield from such a furnace is 250 tons per week.

The blast is under a pressure of $3\frac{3}{4}$ pounds, and is heated to from 650° to 750° Fahrenheit. From four to six tuyeres are usually employed. No. 1 iron for the Bessemer process from these furnaces brings 90 shillings per ton at the works, and No. 2, 10 shillings per ton less.

The Wigan Iron and Coal Company, Lancashire, produce an iron which is used to a considerable extent for the process, but does not rank as high as the Cumberland irons. The coal as mined would be quite unfit

for use in the production of such a grade of iron, as it is materially contaminated with sulphur, but this is almost entirely removed by washing the fine coal, the pyrites settling by their superior weight, while the pure coal is carried on to receiving beds by the current of water, and the purified residuum is then converted into coke, yielding a tolerably strong product. This company have just erected a number of new furnaces much above the usual size for this kind of iron, viz., 80 feet high and 24 feet diameter of boshes, and these are provided with a cone and bell arrangement for taking off the gas.

Forest of Dean iron, made from brown hematite ores, is frequently used in small quantities in admixture with other irons for the purpose of maintaining the heat of the charge, which it tends to do. It is apt, however, to contain too large a percentage of sulphur to work well alone.

Another brand which is said to work well is Weardale, an iron made from spathic ores. It is unusually rich in manganese, and owes its excellence chiefly to that fact.

The following analyses exhibit the characteristics of some of the more usual brands of iron employed:

	Cleator.	Workington.	Weardale.	Forest of Dean.
Carbon, (graphitic)	4.007	3.14	3.24	3.25
Silicon	1.752	3.12	1.80	1.36
Sulphur	....	0.05	0.04	0.037
Phosphorus	0.049	0.03	0.19	....
Manganese	....	0.02	1.45	....

The analysis of Weardale is taken from Percy's Metallurgy; the others were furnished to the writer from different sources in England.

The presence of silicon in the iron causes the charge to work hot in the converter, and it is usual therefore to mix an iron rich in this element with others containing a less quantity, and which have a tendency to work cold and become pasty. As a rule Workington iron contains more silicon than any other in use for the process, and being moreover an excellent iron is largely used. It is, however, from the very fact of its working so hot, seldom employed alone, as it cuts the moulds badly in pouring.

Sulphur and phosphorus are the most injurious elements found in the pig, because the pneumatic process is powerless to remove them, and the quality of the steel is materially affected by their presence. An effectual means of eliminating these substances, in the process of conversion, would be one of the most valuable discoveries of the times.

It is usual among all the steel makers to mix several different brands of iron where a uniform and good quality of steel is desired, but there seems to be no definite mixture which is agreed upon as best. The principle appears to be to form the larger portion of the charge of the better brands of Cumberland hematite, and to add as correctives smaller per-

centages of other irons. The following will serve as examples, the first having been given to the writer by Mr. F. Preston, late managing director of the Lancashire Steel Company, and the other being from the books of another large firm:

I.	
Workington	45
Harrington	40
West Cumberland	10
Wigan	20
Weardale	7
Forest of Dean	3
	120
Spiegel	7½
	127½

II.	
Cleator	40
Workington	20
Harrington, (No. 1)	15
Harrington, (No. 2)	5
Forest of Dean	10
Wigan	3
	93
Spiegel	6¼ or 6½

For forgings, such as axles, tires, locomotive crank shafts, &c., none but No. 1 iron is commonly used, but for rails a greater or less amount of No. 2 is added, in order to reduce the cost as far as possible.

The amount of this quality that may be used will of course depend on the character of the iron.

The iron as a rule is melted in reverberatory furnaces, but at five works cupolas have been substituted with apparently good results. These are—

The Manchester Railway Steel and Plant Co.;

Messrs. Chas. Cammell & Co., Penistone;

The Bolton Iron and Steel Co.;

The Barrow Hematite Iron and Steel Co.;

The Mersey Iron and Steel Co., Liverpool.

At the latter a cupola is also employed for melting the spiegeleisen. At the first-mentioned works Woodward's patent steam-jet cupola is employed, it is stated with a consumption of coke as low as 1¼ pound per hundred-weight of iron. At the others, Ireland's upper tuyere cupolas are employed. These cupolas melt very rapidly, and are sufficiently capacious to hold an entire charge in the portion below the upper row of tuyeres. The size erected for a five-ton plant is seven feet in diameter, and will melt five tons of iron in three-quarters of an hour. In working, the charge is weighed when it is put into the cupola, and, as it melts, remains in the bottom till the whole has been fused, when it is tapped off into the converter. They generally require cleaning once in 24 hours. Of course where cupolas are used, much greater care has to be exercised in the selection of the coke, as fuel which might be used in the air furnaces would destroy the quality of the iron if burned in contact with it. The opinion among those who employ the cupolas is, that it is quite possible to find a coke sufficiently free from sulphur to yield a satisfactory result. At the Barrow works, preparations had been made to convey the molten metal directly from the blast furnaces to the converters, but

after a number of trials it was found that the uniformity of the metal could not be relied on, and, in consequence, the attempt was abandoned, and cupolas erected instead, to remelt the pigs. The converters at the majority of the works have a capacity adequate for a yield of five tons of steel, or allowing one-sixth for waste, which may be taken as a fair average, for six tons of molten iron. At Barrow, however, three seven and a half ton vessels have been erected, besides their five-ton plant, and at Messrs. John Brown & Co.'s a pair of ten ton vessels have been in use more than three years. The material commonly employed for lining the vessels is ganister, a highly silicious substance, found at Sheffield. Other materials have been tried at some works, as, for example, at Dowlais, with apparently great success. A pair of vessels, at the works just mentioned, had recently stood 300 blows each, without relining, and were still apparently in good condition. This is much above the average endurance of the refractory linings. The destruction of tuyeres is an important item in the expenses of the process. The average life of these is seldom over five blows, and the failure of one during a blow is often the cause of considerable loss, either by damage to the vessel or by injury to the contained charge.

In the general arrangement of the Bessemer plant, very few changes have been made from that planned by Mr. Bessemer and contained in the drawings supplied to his licensees. A pair of converting vessels usually placed opposite to each other, but in some cases side by side, stand at the side of a casting pit, sunk a few feet below the general level of the floor. These vessels are mounted on trunnions, and are revolved on them by means of a rack and pinion operated by hydraulic pressure. The melting furnaces are placed in a room having a considerably higher floor level than the converting room, so that the melted metal may be run by its own gravity into the mouth of the converter, when the latter is turned down suitably to receive it. In the centre of the pit is a vertical hydraulic piston or crane, carrying at its upper end a platform, at one end of which is a ladle sufficiently large to hold the contents of the converter at the end of the operation. The platform is furnished with gearing, so that it may be easily revolved to bring the ladle over each ingot mould successively, the latter being arranged accordingly in the arc of a circle near the side of the pit, which here has the same form. The ladle is provided with a nozzle and stopper in its bottom, by means of which the flow of the steel is regulated. Two hydraulic cranes, consisting simply of vertical pistons, carrying a long horizontal jib with a rolling carriage, to which a chain and hook is attached for lifting the ingots, are placed near the edge of the pit, about opposite the centre of the converters, and serve also to lift off the various parts of the latter when required for repairs. The blast valve and hydraulic apparatus pertaining to the converters are worked from a valve stand, placed at a suitable distance from the pit, the cranes being operated by a valve directly attached to them, so that the attendant boy may the

better see what he is required to do, and the whole of the manipulation of the vessels, ladles, and ingots, gives an ease of working and a perfection of control, with economy of labor, which should lead to the more general application of hydraulic power to other departments of industry in which large masses have to be dealt with. The water pressure used for the purpose is about 300 pounds per square inch. The sizes of ingots most commonly cast are, for rails, about 10 inches square, for locomotive crank shafts, ingots of a rectangular section, say 22 inches × 16 inches, and for other forgings according to the size and nature of the work, the moulds having a weight about equal to that of the ingots. At some works, the plan is adopted of testing a sample of each blow for carbon, and classifying the metal according to the result of this test. By this means much greater uniformity in the finished work is obtained, and in the present state of our knowledge of the process, this is a very necessary means to secure this end, and should be more generally adopted. The process employed was introduced from Sweden, and is exceedingly simple in its nature. It consists in dissolving a known weight of metal, in the form of drill chips, or some other finely divided state, in nitric acid, of the gravity 1.2. The solution will have a brown color, more or less deep according to the percentage of carbon contained in the metal. A standard color, corresponding to a known percentage of carbon, as determined by direct analysis, is first established, and the color of the solution to be tested is made to agree exactly with this by the addition of a certain quantity of acid or water. That this, which is the readiest method of producing agreement, may be employed, the color of the standard solution must be light. The water is added to the solution in a graduated test tube, so that the exact proportion of water relatively to the original solution may be read off with ease, and if, for example, an equal bulk of water requires to be added to make the color the same as the standard, the percentage of carbon in the specimen under test must be just double that of the standard. As a solution of steel in acid would in the course of time change its color, an exact imitation of it is made by dissolving burnt sugar, and this is kept hermetically sealed for comparison. To secure a light standard color, it is not necessary that the piece of steel dissolved should contain a small percentage of carbon, but a larger quantity of acid may be used in a known proportion, say twice or three times the required amount, and the corresponding percentage of carbon will be equally well ascertained. This test is easily and quickly applied, and the variation of color being considerable, gives results sufficiently accurate for the purpose of a proper classification of the ingots according to the purposes for which they are suited.

The principal uses to which the Bessemer metal is put in England, are the manufacture of rails, tires, axles, machinery forgings, and boiler plate. The total amount produced may be judged from the fact that the quantity made per week at the works of Messrs. John Brown & Co., limited, and Messrs. Chas. Cammell & Co., limited, is stated to be 600 or 700 tons

each. The number of establishments at which the process is in operation is about 15, and the number of converters employed upwards of 50. The chief market is for rails, and a large proportion of the orders are for *American roads*. In England, not much ordinary line has been laid with steel rails, but on most roads those portions which are exposed to excessive wear, such as stations and inclines, are being relaid with steel. The public are already familiar with the vastly superior endurance of steel in such situations, and nothing need therefore be said here on that point.

MANUFACTURE OF STEEL RAILS.

It is usual, as already stated, to cast a 10-inch square ingot for rails. At most works, this is heated in a reverberatory furnace and hammered down to 7 inches square. At some prominent establishments, however, this process is dispensed with, and a 10-inch ingot is taken directly to the rolls and rolled down to 7 inches. At Crewe, Mr. Ramsbottom employs a heavy cogging machine for the same purpose. This is simply a form of reversing rolls made exceedingly large, and only performing a part of a revolution at each pass of the ingot. It is stated that the rails made from unhammered ingots stand equally good tests with those which have first undergone hammering.

The substitution of rolling of course cheapens the manufacture and reduces the amount of plant necessary, as well as the number of hands required. It is usual after the ingot has been brought from 10 inches down to 7 inches to put it back into the heating furnace for a short time, to bring it up to a heat sufficient to carry it through the remainder of the process. With hammered ingots it is usual to allow them to become cold after hammering, and to reheat them entirely anew, since it is not easy to regulate the heats so as to have the hammer supply hot ingots to the furnaces for the rolling mill. This, of course, involves a further additional expense in the use of the hammer. In heating the ingots care has to be taken that the heat is not forced so as to burn the steel, and ample time must be given for it to "soak." Practically about four heats are obtained in twelve hours, where with iron seven or eight could be got. When the ingots are rolled from the cast size it is usual to provide larger furnaces and a greater number for the first heat than for the second, as the fewer and smaller ones will work off the same number of ingots, on account of the shorter time necessary to bring them to the required heat. At the Dowlais works, for example, there are seven furnaces holding seven ingots each for the first heat, and but four holding four apiece for the supplementary heating.

The usual size of rolls for steel rails of the English (80 lbs per yard) or other pattern is from 22 inches to 24 inches diameter. In some cases, however, smaller sizes are in use, as at Crewe, and at the Mersey iron and steel works, at the latter of which only an 18-inch train is employed. These, however, are trains which were originally intended for rolling iron rails, and have been compelled to do service for steel.

The speed with rolls of the first mentioned sizes varies from sixty to forty revolutions per minute; the former extreme, however, seems preferable. The drafts on the rolls are made somewhat lighter and more numerous than for iron—say two more grooves for finishing.

At several works reversing rolling mills have been erected, to avoid the necessity of lifting the ingots in returning, and also to save time by operating on the ingot when moving in either direction. The usual plan has been to effect the reversing by engaging by means of a clutch gears running in opposite directions. This necessarily brings a severe shock on all the machinery, especially at high speeds, and in some cases where the arrangement has been introduced it is not used, the mill always running in one direction, and the rolling being carried on in the usual way. Mr. Ramsbottom has constructed and patented a reversing mill, which he uses for rolling locomotive frame plates, at Crewe, which is free from this objection. He drives his rolls by a pair of engines, resembling a set of locomotive engines in most of their details, and without any fly-wheel. These work at a high speed, and are geared to the rolls in such a manner as to reduce the speed to the required amount. The link motion is thrown up or down in reversing by a hydraulic piston, easily set in motion by the attendant, and by these means the engines can be reversed seventy times per minute and entirely without shock. This principle for reversing would appear much preferable to the use of a clutch. The employment of a fly-wheel is not found necessary, as the engines, in virtue of their high speed, contain power sufficient to overcome any obstacles within the limits of safety to the rolls, beyond which it is better that they should stop. Mr. Ramsbottom has adopted in this set of rolls a thorough application of hydraulic power for all the operations of manipulation, and has thereby obtained great facility of working and economy of labor. Instead of the reversing principle, a steam or hydraulic lifting gear is used at some works for raising the ingot to the level of the top of the upper roll, and by many this is preferred to reversing.

The Siemens furnace is coming extensively into use in steel works for heating ingots. At present they are in operation at Crewe, Bolton, Barrow, the Mersey works, and some other places. They require a certain amount of care in their management, but yield very satisfactory results in their working. They are expensive in first cost, but in districts where coal slack is abundant they are exceedingly economical in respect of fuel, since they allow of the use of this cheap material instead of better and more expensive coal. But even where good coal must be employed in the gas producers, the utilization of all the heat produced by combustion renders the saving of fuel very considerable as compared with the ordinary reverberatory furnace. For steel an excessively high temperature, such as is required for some operations, and which alone the Siemens regenerators are able to give, is not necessary, and where much steam power is required it may be quite as economical to employ

the waste heat from the furnaces for heating the boilers as to pass it through regenerators for the purpose of heating the incoming gases for the furnaces themselves. In such a case as much and more expensive fuel might be required for generating steam under independent boilers as would be saved at the furnaces by the use of the regenerators. In this connection may be noticed a plan that has been adopted at the Bolton works with good results, viz: the heating of boilers by gas drawn directly from the gas producers. This, of course, gives the same economy in respect of the use of slack as already referred to. Where sufficient steam is already obtained or is not required at all, the regenerative furnaces are of undoubted advantage. Mr. Webb, at Bolton, states that it is still an open question with him whether it is preferable to heat his boilers, as already mentioned, by gas, or to place them over furnaces fired in the ordinary way with coal.

The sawing, straightening, and punching of rails are conducted in general as in America, with the exception that a single saw, or a pair side by side, instead of two separated by the length of the rail, is used. The length of the rail is regulated by stops on the carriage, one end being sawed off and the rail then passed along on the friction-rollers in the carriage till it reaches the stop, when the other end is cut off. The use of a single saw, it is claimed, enables the cut to be made at the most suitable point, as indicated by the appearance of the end, and also gives greater facility in varying the length of the rail as required for different orders. At Barrow, the rollers in the saw carriage are driven by friction gearing from the saw engine, so that the rail is passed along automatically; the carriage is also drawn up to the saw by a number of racks and pinions at intervals along its length driven in a similar manner.

At some works severe tests are adopted for ascertaining the quality of rails, and until more accurate knowledge of the nature of the Bessemer ingots is obtained some such tests would appear to be very necessary. The usual method of procedure is to place a rail from each lot made from one mixing of metal on supports three feet apart, and let fall upon it midway between them a weight of one ton from heights varying from 10 to 30 feet, and observing the deflection produced. It is considered that good rails should not break under this test, though they may bend considerably where great height of fall is employed.

The use of steel-headed rails is a point of great importance, but one on which at present little that is conclusive can be said. They have been made to a considerable extent at the Crewe works of the London and Northwestern Railway Company for use on that line, and Mr. Webb (formerly of Crewe) has patents for forms and materials of piles for their production. One of the points which Mr. Webb claims is interposing a layer of puddle bar between the steel face and the fibrous iron, for the purpose of making a more gradual transition between the crystalline and fibrous metals, and thereby securing a more perfect union in the successive layers. The same thing has been done for many years in the United

States. In the Exposition specimens of steel-headed rails of French manufacture are shown, which have been struck on the top of the head with a steam hammer, cracking vertically through both steel and iron, and buckling up the web without any appearance of separation between the steel face and the iron beneath it. Although the specimen gives no evidence of being a selected one, (the line of the weld being plainly marked on the external surface,) yet it is clear that no such test can decide a question which can really only be properly solved by experience under the conditions of regular working. A sudden blow may be incompetent to produce effects which may follow prolonged and irregular hammering under the wheels of railway trains. While, therefore, steel-headed rails cannot be pronounced an absolute success, there is every reason for prosecuting the experiment, and reasonable grounds for anticipating a perfectly successful result.[1]

As the production of rails is at present the largest branch of the Bessemer steel manufacture, the disposition to be made of the crop ends becomes a question of immediate importance, and that to be made of the worn-out rails one of future moment. As the metal, when it contains any material proportion of carbon, is unreliable when welded, it is not so easy to decide to what use the large amount of ends sawed off from the rails shall be put. At present it must be admitted they are rather a drug in the market. When an iron that works hot in the converter is used, a certain quantity of these ends may be remelted in the vessel without injury to the steel. About four hundred weight per charge of five tons is considered admissible at the Dowlais works, the scrap being first heated to a red heat in a furnace placed near the vessel, and thrown into the latter before running in the molten iron. It is difficult, however, to dispose of the whole amount in this way. As large a portion as possible is sold to the Sheffield crucible steel makers, who remelt them, and sell them at a greatly advanced price. At some works, again, they are rolled into small plates, and in this form they may be used for the manufacture of plough shares and other kindred objects; or in some cases they may be rolled and drawn into telegraph wire; it would be impossible, however, to make fine sizes of wire from them. If the difficulty of disposing of the steel scrap is to continue, it forms another argument in favor of steel-headed rails, since these, when worn out, would contain but little steel and could be readily piled and rerolled, the pile being so arranged as to bring the steel in the least vital parts of the rail in case its presence should lead to any unsoundness of the welding. It would appear, however, that an adequate market for old rails could be formed by rerolling them into the form of bars for machinery and other purposes, for which, by reason of their superior strength, they should be more valuable than wrought iron.

---

[1] Experiments made in the United States, after a trial of two years, have demonstrated that a perfectly sound weld of the steel to the iron can be secured in the head of the rail.

MANUFACTURE OF TIRES.

Next in importance to the manufacture of steel rails is that of tires for locomotive and railway carriage wheels. Four years ago it was attempted to weld these up, as in the case of iron from straight bars, but the unreliability of all tires so made was soon apparent, and the attention of manufacturers was directed to discovering some practicable means of producing them without welds. With the exception of the form of the ingot cast for the purpose, the mode of manufacture adopted at all the English works has attained a remarkable degree of uniformity. Mr. Ramsbottom casts his tire ingots in the form of a truncated cone, a usual size being two feet diameter at the bottom, six inches diameter at the top, and thirty inches height. This he hammers on its ends and sides till it assumes the shape of an ordinary flat cheese, with a thickness of about twelve inches. Another heat is then taken on it, and it is then placed under a steam hammer furnished with a pointed conical tool, and by successive blows with this on both sides a hole is forced through the centre of the disk, and this again expanded as the hammering proceeds, till the upper part of the tool, which is flat, comes down upon the tire and consolidates the metal by reducing its thickness. A third heat is then taken, and the ring so formed is placed over a stout beck projecting from the inclined side of an anvil, which maintains the ring in such a position as to give a suitable bevel to the outer face when struck by the hammer, while at the same time its diameter is considerably increased by the operation. After this third hammering it is ready for the rolls, and a fourth and last heat is taken for that purpose. Mr. Ramsbottom holds a patent for the method of punching the tire blocks by a sharp-pointed conical tool without the removal of any of the metal. The form of rolling mill employed by Mr. Ramsbottom is exceedingly complicated, and is the only one of its kind, as far as the writer is aware, which is in use in England, unless it be at the works of the patentee, Mr. Jackson, at Manchester.

At Mr. Allen's works, Sheffield, (H. Bessemer & Co.,) the cheese-shaped blocks are produced from an ingot of the ordinary square form, this being cast sufficiently large to form a number of tires, say four, and then hammered round and cut up into sections, each of a weight suitable for one tire. The central hole is punched by flat-ended punches about eight inches in diameter at the lower end, and perhaps nine inches above, driven in from both sides successively, and knocking out a circular disk about two inches thick as scrap. The blocks used with this process are of less thickness, say seven inches. The hole so formed is slightly enlarged by forcing the ring down over a truncated conical block which is placed on the anvil for the purpose, and subsequently another heat is taken, and the hammering continued on the inclined back of an anvil, as already described. The weight of the block can be accurately adjusted by varying the thickness at the time of punching out the central

disk, by which means the amount of metal removed will be effected. Another plan adopted by Mr. Allen is to cast annular ingots, sometimes a number, one above the other, fed from one gate. These are cast with considerable depth, so as to allow of sufficient hammering to thoroughly consolidate the metal, and the weight is regulated by the size of the central core employed. For rolling the tires from the hammered rings he employs the tire-mill constructed by Messrs. Galloway & Sons, of Manchester, which is the simplest one in use, and gives results probably not at all inferior to those of other more complicated forms. It is the one most generally adopted in England. The only other variation in the tire-making process is, that at some works, for the purpose of avoiding the severe one-sided strain brought upon the hammer by the use of the inclined beck for bevelling the rings, the ring is placed on a stout mandrel supported on a bifurcated anvil, and the necessary bevel is given by a tool of the proper shape with which the hammer is furnished. In Galloway's and most other tire-rolling machines the roll spindles are placed vertically and extend to a considerable distance below the horizontal bed of the machine. The rolls themselves are situated just above the surface of the latter, with no bearing above them, the spindles being long and stiff enough to resist all the strain coming upon them. The tire is thus readily dropped over the ends of the rolls and removed when finished. Its diameter is determined by a simple sliding gauge, measuring from the centre of the internal roll to the inner face of the tire at its greatest distance from the former. Bessemer steel tires by the above processes are now made in great numbers and give good satisfaction in use. There are some who still prefer the crucible steel for this purpose, but the difference in cost is so largely in favor of the Bessemer metal that it is probable the former will eventually cease to be made.

MANUFACTURE OF BESSEMER PLATES.

The application of the Bessemer process to the production of plates either for boilers or for ships, girders, &c., is one of the most important that could be made. Nevertheless the amount of metal used for this purpose in England falls much below that employed for other purposes. This is due to a certain amount of distrust of steel plates, doubt as to its reliability under varying strains of tension and compression, its capability of being punched and sheared without injury to itself, and of its action under the influence of heat and water as in the fire-box of a boiler. In other countries, as for example Austria, as will be shown when we come to speak of the manufacture as carried on in that country, this has not been the case, and large quantities of plates have been produced and successfully applied to a variety of uses.

The secret of the distrust in regard to Bessemer platesin England is that in nearly all cases the percentage of carbon contained in the metal has been too large. The spiegeleisen used in England is not particularly rich in manganese—seldom exceeding nine per cent. of that element,

while it generally contains from four to four and a half per cent. of carbon. It is difficult, therefore, with such materials to deoxygenate the metal sufficiently without introducing also a considerable percentage of carbon. About 0.4 per cent. of the latter is as large an amount as is proper for plates which are to resist severe strains, and though a greater proportion adds materially to the tensile strength of the metal when measured simply by a direct pull, it renders it also much harder and more liable to crack under the treatment to which it is exposed in the ordinary methods of construction. The difficulty in the way of producing good soft plates for boilers or other uses appeared at one time to have been satisfactorily overcome by the substitution of ferro-manganese in the place of the ordinary spiegeleisen. The manufacture of this substance was commenced by a firm in Glasgow as a branch of another business in which they were engaged, and plates made with it as a deoxygenator gave most excellent results. Unfortunately, however, the firm who had undertaken the manufacture shortly afterward became insolvent, and the patentee of the process has not as yet re-established the manufacture (which requires a considerable expenditure for suitable furnaces) elsewhere in England. Had the use of this substance continued for a longer time, so as to make the excellence of the steel produced with it fully appreciated by the public, there would have been a demand for plates urgent enough to have immediately secured the re-establishment of the manufacture; but in the present state of feeling it may not be so easy to induce the necessary primary outlay, especially as a certain amount of ill feeling is said to exist between the owners of the ferro-manganese patent and the Bessemer interest. The percentage of manganese contained in the alloy produced by the process referred to varied from 15 to 25. Another kind of ferro-manganese, containing a much larger percentage and produced in Germany by a different process, also the subject of a patent, has been offered in the English market, but at such an exorbitant price that nobody has ventured to buy it. Still, notwithstanding the absence of ferro-manganese, good soft plates are produced at some works, especially those at Bolton. Messrs. Charles Cammell & Co. also make a large number of plates of good quality. The following tests, which they guarantee all their plates to stand, are interesting.

Tensile strain per square inch, 33 tons.

Forge test, (hot.)—All plates one inch thick and under to bend hot without fracture to an angle of 180°, both lengthways of the grain and across.

Forge test, (cold.)—All plates will admit of bending cold without fracture as follows:

Bessemer plates.

	With the grain.	Across the grain.		With the grain.	Across the grain.
	°	°		°	°
1 inch	45	25	7/16 inch	90	70
7/8 inch	50	30	3/8 inch	110	80
3/4 inch	60	40	5/16 inch	120	90
5/8 inch	70	50	1/4 inch and upwards	120	100
1/2 inch	80	60			

To show the comparison of this steel with the regular crucible steel, the guarantee for plates of the latter is also given.

Crucible steel plates.

Tensile strain per square inch, 38 tons.

	With the grain.	Across the grain.		With the grain.	Across the grain.
	°	°		°	°
1 inch	50	30	7/16 inch	130	100
7/8 inch	60	35	3/8 inch	150	110
3/4 inch	75	50	5/16 inch	180	120
5/8 inch	90	70	1/4 inch and upwards	180	120
1/2 inch	110	90			

Probably the spiegeleisen used for this purpose is selected with especial care and may contain as much as eleven per cent. of manganese without an increased proportion of carbon. By a proper system of testing the ingots, as described above, there should be and is no difficulty in ascertaining just what percentage of carbon is contained in the metal, and so selecting ingots that are suitable for this purpose. With the superior franklinite that we possess, together with the purer irons, there is, apparently, no reason why we should not produce most excellent plates in large quantities, as is already done in Austria.

The manufacture of axles is carried on to a considerable extent, both for locomotives and railway carriages. Locomotive crank shafts are now more frequently made of this material than any other, and with a far greater exemption from breakages. These are usually forged from large rectangular ingots, and twisted to the proper angle as in the case of iron. To bring these large masses down properly with economy requires very heavy hammers, and to meet this want Mr. Ramsbottom has erected to Crewe a thirty-ton hammer, on his patent duplex principle. In order of dispense with the costly foundations necessary to sustain the impact at the falling tup in large hammers, Mr. Ramsbottom designed about five years since a hammer in which the blow should be struck by two heavy masses mounted on wheels, and moving horizontally in opposite directons, so that their momentum should be annihilated in striking the ingot placed between them. In the first of these hammers, in which the weight

of each tup was ten tons, the cylinder was placed vertically in a pit beneath the hammer and the piston, connected by inclined links to each tup, so as to communicate motion to them on the rails. The ingot was supported on a suitable table, or between a pair of stout centres, which again rested on a platform capable of being rocked slightly to maintain the ingot always exactly in the centre of the motion of the tups. A number of these hammers are at present in use, and though they constitute the first development of a new idea, they do their work tolerably well, though they need a greater amount of care than an ordinary hammer. In the thirty-ton hammer which has been more recently built, the design has been somewhat modified, and greater simplicity obtained. In this the steam cylinders are horizontal, and placed directly behind each tup, the piston rods being secured to the latter by an elastic packing, so as to relieve the piston from the shock of the blow. To control the motion of the two tups, so that they shall always meet at the same point, a five-threaded screw with a diameter of six inches and a nine-inch pitch, or once and a half its diameter, is placed beneath them, the thread being cut left-handed at one end, and right-handed at the other. A nut secured to the bottom of each tup works on the portion of the screw beneath it, and as the screw revolves in its bearings each tup advances by the same amount. This arrangement is found to work with but little friction, and is not liable to derangement. The valve gear is made to be worked by hand in the ordinary way. The size of the cylinders and pressure of steam are so proportioned as to make the pressure on each tup the same as its weight, and the blow struck by this hammer is therefore the same as would be given by one of the tups falling by gravity through a distance equal to the combined stroke of the two tups, or seven feet. These hammers have been constructed by Messrs. Thwaites & Carbutt, of Bradford, who have had great experience in this line of business, having perhaps supplied more hammers to the steel-makers than any other firm. With the heavy hammers just described, the large ingots for crank axles are brought down to the required size and shape in a very short time. At Crewe it is usual to put two of these ingots into the Siemens furnaces in the evening, and allow them to heat slowly during the night, but one man being required to be in attendance, and then to work them off under the hammer in the morning before breakfast. In sawing off the ends of his finished axle forgings, Mr. Ramsbottom employs a saw seven feet six inches in diameter, running at about nine hundred revolutions per minute, or a speed on the edge of four miles per minute. The cheeks are also sawed out preparatory to turning the crank wrists.

In concluding the account of the Bessemer manufacture, as at present conducted in England, we may observe that while the amount produced is far in excess of that to be found elsewhere, yet from the close competition between the different makers tending to favor the use of the cheapest materials, and from the naturally rather inferior character of

the native iron employed, the quality of the metal is not equal to that produced in countries using better materials. Accordingly the uses to which it has been chiefly devoted have been rails, tires, and axles, together with a certain amount of plates. Notwithstanding this there have been produced, when proper substances have been employed, specimens of the metal which seemed able to undergo almost any test that could be devised. It has been spun into ornamental vessels of shapes such as would bring the most severe strain on the metal without exhibiting any sign of cracking, or bent into the most crucial shapes, with equal evidence of its toughness. We shall see on examining the product of other countries that such qualities in the metal are not at all exceptional, but that when steel of great hardness is not intentionally produced, they always exist.

SWEDEN.

An examination of the specimens of Bessemer steel from Sweden in the Exposition shows us that the metal there produced is of a far superior character to that made in England, and naturally leads to inquiry as to the cause of the difference, and whether we may hope to attain the same success in the United States. First we observe coils of wire of all sizes, down to the very finest, such as No. 47, or even smaller. This they have not been able regularly to produce in England. In the next place we notice a good display of fine cutlery, and the writer is informed by a competent authority that this metal answers so well for this purpose that it is now used almost to the exclusion of any other. This statement is corroborated by the fact that in the miscellaneous classes of the Swedish department, where cutlery occurs not as an exhibition of steel, but merely as a display of workmanship by other parties in the same manner as other articles of merchandise, cases of razors are exhibited with the mark of the kind of steel of which they are made stamped or etched upon them as usual, and these are all "Bessemer," but from a variety of different works, viz: Högbo, Carlsdal, Österby & Söderfors. The ore used in Sweden for producing iron for the Bessemer process is exclusively magnetic, and of a very pure quality. An analysis of a mixture of those used for the iron employed at the Fagersta works before roasting gives the following composition:

Carb. acid	8.00
Silicium	17.35
Alumina	0.95
Lime	6.50
Magnesia	4.35
Protoxide of manganese	3.35
Magnetic oxide	32.15
Peroxide of iron	27.40
	100.05
Phosphoric acid	30

All the pig made from this mixture of ores the exhibitors state will give a steel without the use of spiegeleisen, which is not at all red short.

The analysis of gray iron from the same works, used for the Bessemer process, is given as follows:

Carbon combined	1.012
Graphite	3.527
Silicium	0.854
Manganese	1.919
Phosphorus	0.031
Sulphur	0.010

The cinder, produced at the same time as the gray iron, shows on analysis a composition of—

Silica	53.30
Alumina	3.00
Lime	21.10
Magnesia	13.95
Protoxide of manganese	7.85
Protoxide of iron	0.90
	100.10

The analysis of mottled pig, *(la fonte truité,)* consisting of two-thirds gray and one-third white, is—

Carbon combined	2.138
Graphite	2.733
Silicium	0.641
Manganese	2.926
Phosphorus	0.026
Sulphur	0.015

Of each of these it is stated that the steel produced without the employment of spiegeleisen is not at all red short, *(cassant à chaud.)* The most noticeable feature in the composition of these irons is the large percentage of manganese which they contain, together with the extremely minute proportion of sulphur. The latter quality is due to the exclusive employment of charcoal in the blast furnaces, together with the adoption of a very high temperature in the roasting kiln. These latter are constructed on Westman's patent, and are made very high and heated by the waste gas drawn from the blast furnaces. The heat is carried as high as is possible without agglomerating the materials, and by this treatment the ore is changed from a hard and compact substance to a very porous one, while at the same time it is stated that any percentage of sulphur less than four per cent. is driven off. The blast furnaces are very small, being generally but eight feet in diameter at the boshes and about three feet at the hearth, with a height of forty feet. With these ores prepared in this manner, such a furnace will yield from seventy to eighty tons per

week. It is thought by the best informed engineers in Sweden that these furnaces should be made larger, and in future they probably will be so; but these dimensions represent the furnaces that now exist, and with which the iron in use has been produced.

In the process of conversion, from motives of economy, a fixed form of vessel is employed, instead of one mounted on trunnions, as in England and elsewhere. The tuyeres, about nineteen in number, are placed horizontally just above the bottom of the vessel, and are inclined a little from a radial direction so as to give a rotary motion to the mass of molten metal. An air passage surrounds the vessel at the back of the tuyeres, with a movable plate opposite each to allow access to them. The upper portion of the vessel, from the line of the top of the blast passage, is made removable, for lining, &c.; the bottom of the vessel is slightly inclined towards the taphole, so that the whole of the metal and slag may run off. The metal is run in at a spout in the upper portion of the vessel, and from the fixed position of the vessel it is of course necessary to have the blast on all the time that the metal is being run in and drawn off, to prevent its flowing into the tuyeres. This fact must make it more difficult to regulate the exact amount of decarbonization of the metal, and tend to render the last portion drawn off overdone. The removal of the cinder remaining in the vessel after a blow is not so easily accomplished in the fixed vessels as in the revolving one, as ordinarily used.

Accompanying the analysis of ores and irons, given above, the Fagersta works exhibit an analysis of the slag from the converter, taken at the close of the process, and it shows the composition to be as follows:

Silica	44.30
Alumina	10.85
Lime	0.65
Magnesia	0.45
Protoxide of manganese	24.55
Protoxide of iron	19.45
	100.25

The case of specimens exhibited by these works is the most interesting by far in the Exposition. It contains a most extensive collection of pieces of various forms, with which a very elaborate set of experiments has just been made at Mr. D. Kirkaldy's testing works at London, the result of which will be found in Appendix D. The samples are classified according to the percentage of carbon which they contain, and have been tested to show their action under strains of tension, compression, torsion, bending, and, in the case of plates, bulging.

The amount of carbon contained in the steel varies from 0.1 to 1.50 per cent., though most of the experiments were made between the limits of 0.3 and 1.20 per cent. In addition to the large collection of test pieces, they exhibit some railway carriage axles containing 0.3 per cent. of carbon, *one being bent double* with a radius of curvature at the bend of about 5

inches; a locomotive axle containing 0.4 per cent., and a tire having 0.5 per cent. of carbon. There is, also, as already mentioned, a fine display of cutlery, razors, some beautiful hand mirrors containing 1.0 per cent., a small drill containing 1.50 per cent., with a plate beside it containing 1.00 per cent., through which it had drilled several holes; a number of long turnings taken off in a lathe, showing remarkably the absolute continuity of the grain—one of 0.3 per cent. of carbon measures 36 feet in length, and is closely coiled with a diameter of about $\frac{1}{12}$ inch; another of 0.9 per cent. is 27 feet long and slightly less in diameter. There are also a large number of files, and, as previously mentioned, coils of wire of all sizes, and apparently any required length. A very interesting table of results was obtained from a series of eleven small square bars containing varying percentages of carbon, as follows:

Strength of steel containing different amounts of carbon.

Number.	Per cent. of carbon.	Sectional area before elongation, square inches.	Breaking weight, in pounds.	Breaking weight, per square inch.	Section after fracture at point of rupture.	Proportion of ruptured section to original section.	Breaking weight per square inch of ruptured section.	Per cent. of elongation.
1	0.35	.2323	16,262	69,730	.0854	36.65	190,250	12.0
2	0.45	.1448	14,663	100,800	.0996	68.5	147,160	10.3
3	0.45	.1398	14,663	104,300	.1150	81.9	130,300	9.2
4	0.70	.234	29,540	125,800	.2026	86.3	145,750	1.56
5	0.70	.1568	16,074	102,300	.1314	83.46	122,300	4.0
6	0.70	.1515	19,841	131,400	.1400	92.05	141,660	5.4
7	0.70	.1485	17,016	114,100	.1230	82.55	138,240	5.8
8	0.90	.1466	19,935	135,400	.1189	80.80	167,500	6.7
9	1.00	.2338	30,012	128,000	.2242	95.69	133,800	2.3
10	1.00	.1516	20,218	132,700	.1400	91.93	144,300	6.6
11	1.00	.1494	21,726	144,800	.1400	93.31	155,120	4.0

The cost of steel for the more delicate uses, such as razors, &c., is very much less by the Bessemer process than by the old method of remelting in the crucible. The materials in ordinary use are sufficiently pure to give such a steel, and the only special precaution which has to be observed in producing these qualities is to add a sufficient amount of recarbonizing pig to give the required per cent. of carbon, and then in the process of tilting the bars to carefully reject any piece which may show sign of flaw, as would of course be necessary under any circumstances. The total production of Bessemer steel in Sweden in 1864 was 3,178 tons; that of crucible steel exceeded 4,500 tons.

AUSTRIA.

The conditions under which Bessemer metal is produced in Austria are in many respects similar to those existing in Sweden. The iron employed is smelted with charcoal, is nearly free from sulphur and phosphorus, and contains a large percentage of manganese. There are differences in the manner of conducting the process, but these important conditions

insure the production of a metal of similar excellence to the Swedish, and, like this, much superior to the ordinary metal produced in England.

The principal works in Austria are at Neuberg, in the province of Styria, and are carried on by the government. The iron is obtained from spathic ores smelted in two furnaces 43 feet high, and yielding from 100 to 150 tons per week. The iron produced is found by analysis to contain 3.46 per cent. of manganese, and, as in Sweden, it is used for recarbonizing in the place of the usual spiegeleisen. Originally a fixed vessel was erected at these works similar to those used in Sweden, but this has been superseded by a pair of three-ton vessels of the ordinary construction. Fixed or Swedish vessels are, however, still in use at other Austrian works. The metal is run directly from the blast furnaces into the converters. Very interesting tables are exhibited by these works, giving analyses of the iron and slag at five periods in its conversion from its condition as tapped from the furnace to its final state as Bessemer metal. These are extremely interesting from the light which they throw upon the relative rapidity with which the components of the pig iron are attacked by the blast, and the permanency of some ingredients, such as phosphorus and copper, during the entire process. The results are as follows:

Analyses of iron and slag during conversion to steel.

	As tapped from blast furnace.	After the disappearance of the sparks from the converter.	After the boiling over period.	End of blowing.	After addition of pig for recarbonization.
IRON.					
Graphite	3.180	....	....	....	....
Carbon combined	0.750	2.465	0.949	0.087	0.234
Silicium	1.960	0.443	0.112	0.028	0.033
Phosphorus	0.040	0.040	0.045	0.045	0.044
Sulphur	0.018	Trace.	Trace.	Trace.	Trace.
Manganese	3.460	1.645	0.429	0.113	0.139
Copper	0.085	0.091	0.095	0.120	0.105
Iron	90.507	95.316	98.370	99.607	99.445
SLAG.					
Silica	40.95	46.78	51.75	46.75	47.25
Alumina	8.70	4.65	2.98	2.80	3.45
Protoxide of iron	0.69	6.78	5.50	16.86	13.43
Protoxide of manganese	2.18	37.00	37.90	32.23	31.89
Lime	30.35	2.98	1.76	1.19	1.23
Magnesia	16.32	1.53	0.45	0.52	0.61
Potash	0.18	Trace.	Trace.	Trace.	Trace.
Soda	0.14	Trace.	Trace.	Trace.	Trace.
Sulphur	0.34	Trace.	Trace.	Trace.	Trace.
Phosphorus	0.01	0.03	0.02	0.01	0.01

From each charge blown at these works a small test ingot is cast, and this is immediately reheated and subjected to a number of tests to ascertain the quality of the steel; and according to the results of these trials, all the metal produced is divided into seven grades of varying hardness, No. 1 being a blue steel, containing from 1.12 to 1.58 per cent. of carbon; and No. 7 a soft iron, with from 0.05 to 0.15 per cent.

The test employed consists in hammering the little ingot into a bar, and subjecting it to severe working on the anvil, in a way which would tend to crack it if of a red, short nature, or of inferior quality. It is then heated and plunged into water, and the amount of hardening produced proved by striking it with a hammer, and observing the amount of flexure produced. It is then heated again and bent over upon itself and welded into an eye, the welded portion being drawn out to a small section and broken off. These tests take but a short time, and the expense of making them is insignificant in comparison with the accurate knowledge thereby obtained of the nature of the steel and the purposes for which it is suitable. As a rule, the steel produced at the Neuberg works welds with great facility, and, in fact, all the tires produced here are welded as in the case of iron. A table of the tensile strengths and other properties of steel, of the various classes below No. 2, is exhibited, and is as follows:

Tensile strength and other properties of steel.

	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.
Percentage of combined carbon.	0.88 to 1.12	0.62 to 0.88	0.38 to 0.62	0.15 to 0.38	0.05 to 0.15
Tensile strength, tons, per square inch.	63.13 to 74.61	51.65 to 63.13	40.17 to 51.65	34.43 to 40.17	28.69 to 34.43
Extensibility	0.05	0.10 to 0.05	0.20 to 0.10	0.25 to 0.30	0.30 to 0.25
Hardening	With care	Very well ...	Very well ...	Feebly	Not at all.
Welding	Very well, as hard cast steel.	Very well ...	Very well ...	Very well ...	Very well.

The softest grade is used for wire, sheet steel, &c., and the higher numbers for boiler plate, gun barrels, axles, tires, tools, and cutlery, according to the hardness required.

A printed list gives the price of the steel in various forms delivered at the works, which, reduced to gold dollars, is as follows: ingots, \$77 50; bars, \$138; boiler plate, \$145 50; tires, \$155 50. These prices are little above those charged in England, where coal is abundant and an inferior quality of metal produced.

PRUSSIA.

In other countries than Sweden and Austria, we find nothing that presents any remarkable feature not to be found in English practice. Of course, Krupp is far ahead of all others in respect to the size of the masses

that he casts. He exhibits in the Exposition a 40-ton (40,000 kilograms) ingot, intended for a crank shaft, which he states was cast from crucibles. His process of making tires is similar to that in use in England. He first makes a bloom about 6 feet long and 13 inches by 10 inches, and then cuts this up into sections of the required weight. A slit is cut through the middle of these, and they are then worked out into an annular form, and afterwards rolled on a mill of a construction similar to those in use in England, with the exception that the bed, instead of being horizontal, is vertical, as if one of those machines were turned up on its edge. Two mills, one for roughing and one for finishing, are employed. His tire-heating furnaces are placed in a pit at the side of the mill, and are similar to the furnaces of a brass foundry, the tires being laid on the fire by a central crane.

FRANCE.

The French also exhibit good specimens of Bessemer metal, but, as already stated, there seems to be no marked advance on what has been accomplished in England, and it will not be necessary, therefore, to notice in detail the articles they have brought forward.

The manufacture has been established at six works, and the production, in 1866, was as follows:

	Tons.
Compagnie de Terrenoire	1,537
Cie. de Chatillon, Commentry	59
Societé d'Imphy, St. Seurin, (Jackson's)	4,858
S. Menans & Cie	000
De Dietrich & Cie	486
Petin, Gaudet & Cie	3,851
Total	10,791

Of this product, 3,687 tons were in the form of rails. In 1863 but three works were in operation, with a total product of 1,857 tons. At the present time the metal produced in France by this process does not stand as high in the opinion of iron-masters as puddled or other steel. It may be that this is due to the nature of the pig iron employed, or it may be due to a lack of experience in the manufacture as compared with other nations.

At the works of Messrs. Petin, Gaudet & Co., near St. Etienne, a pair of six-ton converters have been erected, and a single vessel, capable at present of producing a charge of eight tons, and in which it is expected to make twelve-ton charges when the lining becomes reduced in thickness. This is the largest Bessemer apparatus in France.

Submitted by

FREDERIC J. SLADE,
Scientific Assistant to Committee No. 6.

PARIS, June 15, 1867.

Name of the mine.	Year of working.	Name of chemist.	Percentages of constituents.						Percentages of constituents of earthy matters.						Oxygen of silicic acid and alumina divided by oxygen of the bases.	Quantity of carbonate of lime or of quartz for the fusion in per cent. of the ore.
			Iron.	Oxide of iron.	Earthy matter.	Phosphorus.	Sulphur.	Other matter.	Silica.	Alumina.	Lime.	Magnesia.	Manganese.			
PROVINCE OF NORRBOTTEN.																
Gellivare:																
Fredrika*	1862	L. Rinman	66.8	92.3	7.7	0.019	0		75.5	2.1	11.5	22.9	Trace		37.7-72.5=2.7	
Hertigen af Upland*	1862	do	66.7	92.1	7.9	0.74	0		37.5	12.5	37.5	12.5			25.4-15.7=1.6	
Robsahm*	1862	do	63.6	87.8	12.2	0.038	0		50.0	8.8	20.2	21.0			30.1-14.1=2.1	
Tingvallskulle*	1862	do	65.7	90.7	9.3	0.512	0		44.3	12.2	33.5	8.6		Be: 1.4	28.7-13.7=2.1	
Törefors et Gyljen*	1862	do	68.1	94.0	6.0	0.02	0		55.2	14.6	7.8	22.4			35.6-11.2=3.2	
Välkomma*	1862	do	64.0	88.4	11.6	0.394	0		62.7	2.7	28.0	6.6			33.9-10.7=3.2	
Routivare*	1862	do	54.2	74.9	25.1	0.004	Trace		12.4	25.2	5.4	18.3	1.9	Be: 1.3 Ti: 35.5	18.2-21.4=0.8	
Lousavare*	1861	do	71.3	98.5	1.5	0.105	0		50.0	16.0	1.0	5.2	0.4	Ti: 17.2 Be: 9.2		
PROVINCE OF GEFLEBORG.																
Thorsaker:																
Nyäng*	1860	O. Troili	47.50			0.002	(0.09)a									5 p. ct. of lime.
Strand*	1860	do	48.8			Trace	(0.09)									5 p. ct. of lime.
Erik Ers*	1863	L. Rinman	56.4	77.8	18.8	0.008	Cu. 0.3	C: 3.40	32.2	5.2	29.5	13.3	19.8		19.2-18.2=1.05	
Afze*	1863	H. Limnelius	18.8	26.0	52.0	0.01	0.06	C: 22.0	15.7	8.1	59.0	6.4	10.8		12.0-21.9=0.6	
Penning*	1863	G. L. Wetterdal	46.1	63.7	36.3	0.002	(0.04)		22.3	3.7	16.0	9.4	48.6		13.3-19.3=0.7	
Gymas‡	1859	D. A. Kruhs	36.1	49.9	50.1	0.061	(0.10)		83.5	4.6	7.9	3.3	0.7		45.6-3.7=12.3	
PROVINCE OF UPSALA.																
Dannemora:																
A mixture of 4 of the middle field in 1 of the north field‡	1859	Cl. Ullgren	50.7	69.2	30.8	0.005	0.07	Cu. 0.2	45.0	1.0	26.5	21.3	6.2		23.8-17.5=1.4	
of the south field‡	1859	do	52.3	71.7	28.3	0.008	0.138	Cu. 0.16	48.3	1.4	20.8	20.8	8.7		25.7-16.2=1.6	

Table showing the analyses of the most important ores and iron of Sweden—Continued.

Name of the mine.	Year of working.	Name of chemist.	Percentages of constituents.						Percentages of constituents of earthy matters.						Oxygen of silicic acid and alumina divided by oxygen of the bases.	Quantity of carbonate of lime or of quartz for the fusion in per cent. of the ore.
			Iron.	Oxide of iron.	Earthy matter.	Phosphorus.	Sulphur.	Other matter.	Silica.	Alumina.	Lime.	Magnesia.	Manganese.			
PROVINCE OF UPSALA—Cont'd.																
Dannemora:																
Norra Kungs*	1865	B. Feruqvist	51. 2	70. 7	21. 7	0. 0026	0. 08	C: 7. 6	30. 3	3. 0	27. 4	30. 0	9. 3	....	17. 1-21. 3=0. 8	
Jord*	1865	......do	56. 1	77. 4	18. 0	0. 0026	0. 033	C: 4. 6	33. 3	2. 9	23. 0	31. 6	9. 2	....	19. 0-21. 0=0. 9	
Södra Silfberg*	1865	......do	62. 1	85. 8	11. 7	0. 0033	0. 013	C: 2. 5	35. 2	6. 5	23. 5	21. 7	13. 0	....	21. 3-18. 3=1. 1	
Lena: Sahlsta*	1863	L. Rinman	58. 1	80. 2	19. 8	0. 015	0. 05	C: trace	68. 8	9. 1	9. 1	12. 2	0. 8	....	40. 1-7. 7=5. 2	
PROVINCE OF STOCKHOLM.																
Wahlö: Wigelsbo‡	1862	S. Sjöberg	51. 3	70. 9	29. 1	(0. 01)	(0. 04)	Cu. (0. 13)	59. 6	1. 9	19. 0	19. 2	0. 3	....	31. 9-13. 2=2. 4	
Börstil: Raggazö†	1861	J. O. Björck	49. 7	......	......	(0. 026)	(0. 03)	....	......	......	......	......	......	....	....	
Sand‡	1861	R. v. Stockenström	55. 1	76. 1	23. 9	(0. 026)	(0. 03)	Cu. (0. 052)	55. 7	9. 3	27. 0	7. 2	0. 8	....	23. 2-10. 7=2. 2	
Häfverö: Herräng*	1863	J. F. Lunberg	50. 0	......	......	(0. 014)	(0. 04)	Mn. 0. 28	......	......	......	......	......	....	....	15 p. ct. of qtz.
Do‡	1863	L. Hallgren	57. 9	80. 0	20. 0	(0. 025)	(0. 03)	....	36. 0	3. 9	46. 5	12. 7	0. 9	....	20. 5-18. 5=1. 1	
Broby*	1864	S. Cleophas	50. 1	69. 2	30. 8	(0. 01)	(0. 3)	....	46. 3	7. 9	12. 7	31. 3	1. 8	....	27. 7-16. 5=1. 7	
Utrö‡	1862	J. A. Kullström	82. 0	52. 5	47. 5	(0. 165)	(0. 04)	Cu. (0. 06)	87. 1	4. 2	4. 0	3. 8	1. 4	....	47. 3-2. 8=16. 9	
Do*	1863	J. F. Lunberg	45. 5	......	......	(0. 17)	(0. 03)	Mn. 0. 47	......	......	......	......	......	....	....	20 p. ct. of lime.
PROVINCE OF STORA-KOPPARBERG.																
Leksand: Sörskog*	1859	C. Wahlund	43. 4	59. 9	40. 1	0. 005	(0. 05)	....	63. 4	5. 1	23. 1	5. 4	3. 0	....	35. 3-9. 5=3. 7	
Qvarnback†	1861	A. R. Toren	52. 5	......	......	(0. 04)	(0. 03)	....	......	......	......	......	......	....	....	10 p. ct. of lime.
Ahl: Blackberg‡	1858	F. Lindsback	43. 2	59. 7	40. 3	(0. 042)	(0. 02)	....	59. 3	4. 5	30. 3	4. 9	1. 0	....	33. 0-10. 9=3. 0	
Walsarfsberg†	1855	A. Röhss	39. 2	54. 2	45. 8	....	....	....	61. 1	2. 5	25. 0	Trace	11. 4	....	33. 0-9. 7=3. 4	
Svärdsjö: Wintjern*	1864	A. Andersson	45. 2	62. 5	37. 5	(0. 03)	(0. 01)	....	56. 1	9. 8	15. 1	18. 7	0. 3	....	33. 7-11. 8=2. 8	
Sjö-grafva*	1860	O. Troili	55. 0	......	......	Trace	(0. 04)	....	......	......	......	......	......	....	....	10 p. ct. of lime, & 10 p. ct. qtz.

Harmnarf†	1860	A. Carlson	55.0	77.0	22.8	0.026			58.2	8.8	23.8	8.1	1.1		34.4-10.2=3.4	
Skumaräng*	1863	J. F. Lundberg	49.0			(0.02)	(0.04)	Mn. 14.3								10 p. ct. of qtz.
Tuna: Hästberg‡	1856	C. A. Jacobsson	50.6	69.8	30.2	0.02	0.04		65.0	7.8	23.8	2.2	1.2		37.4-7.9=4.7	
Örns-gr	1864	J. F. Lundberg	62.0			(0.014)	(0.02)									10 p.ct.of lime, & 10 p.ct.qtz.
Säther: Bispberg*	1837 1860	A. Erdmann O. Troili	64.4	88.9	1.1	0.005	(0.05)		47.9	5.2	8.8	10.5	27.6		27.4-12.9=2.1	
Engelsfors†	1859	G. Hjort af Ornäs	55.3			0.025	(0.02)									10 p.ct.of lime.
Rällingsberg‡	1859	L'Ecole des mines	61.0	84.2	15.8	(0.017)	(0.02)		49.	9.8	23.5	15.0	2.6		30.1-13.1=2.3	
Garpenberg: Langvik‡	1861	J. F. Lundberg	43.6	60.2	39.8	(0.02)	(0.02)		18.5	2.3	40.6	16.5	22.1		10.7-23.2=0.5	
Holm‡	1861	......do	47.4	65.5	34.5	(0.02)	(0.05)		37.	1.9	22.6	15.3	23.1		20.2-17.8=1.1	
Axberg*	1858		47.9	66.	32.7	0.013	0.18	C: 1.2	61.6	8.0	23.7	5.8	0.9		35.7-9.3=3.8	
Hag‡	1858	J. F. Lundberg	41.0			0.14	(0.10)									
Folkärna: Knutsbo‡	1861	......do	45.5	62.8	37.2	(0.02)	(0.03)		76.6	2.4	7 8	9.4	3.8		41.0-6.9=6.0	
By: Westersjör†	1859	W. Tamm	41.5	57.3	42.7	Trace	(0.04)		55.7	2.3	30.2	11.0	0.8		30.0-13.2=2.3	
Vestra Ormberg Lilla Pick-grufva*	1861	L. Rinman	67.6	96.6	3.4	0.065	(0.025)		59.	19.8	7.9	5.0		Ce: &c. 7.90	40.1-5.8=6.0	
Abrahams*	1861	......do	60.9	84.	15.9	1.27	(0.015)		62.	9.4	20.5	8.0		Ce:trace	36.7-9.1=4.0	
Kittel*	1861	......do	57.3	81.9	18.1	0.129	(0.03)		60.8	22.9	3.3	3.9		Ce: 9.1	42.3-4.3=9.7	
Grängesberg:																
Bredsjöbrott*	1861	......do	65.	89.9	10.1	0.502	(0.04)		39.2	22.	14.1	24.6		Ce:	30.7-13.8=2.2	
Galthafvud*	1861	......do	59.	85.6	14.4	0.132	(0.035)		80.7	10.3	4.2	4.8		Trace	46.8-3.1=15.1	
Enkulle*	1861	......do	57.7	82.5	17.5	0.101	(0.02)		77.8	11.7	3.2	7.3	Trace		45.9-3.9=11.9	
Godgrufva‡	1862	R. Kullberg	57.6	79.6	20.4	0.04	(0.02)		75.8	12.4	5.7	4.8	1.3		45.2-3.8=11.7	
Fäboback‡	1860	J. F. Lundberg	38.			(0.05)										8 p. ct. of qtz.
Ludvika:																
Främmundberg Tägs†	1862	......do	52.	72.4	27.6	(0.05)	(0.04)		47.8	23.4	8.2	18.7	1.9		35.8-10.2=3.5	
Fumäs‡	1859	G. Hjort af Ornäs	47			(0.07)	(0.31)									15 p.ct.of lime.
Jolke:																
Lejon*	1860	C. H. Lundström	53.2	73.4	26.6	0.034	0.09		73.4	8.8	4.3	11.8	1.7		42.2-6.3=6.7	
Folke:																
Laug‡	1861	J. N. Björlingson	45.4	62.6	37.4	0.04	(0.03)		77.2	10.0	8.9	1.5	2.4		44.8-3.6=12.3	
Haksberg*	1861	C. G. Ekman	47.8			(0.20)	(0.03)									20 p.ct.of lime.
Gräsberg‡	1861	J. N. Björlingson	51.2			0.03	(0.02)									10 p.ct.of lime.
Do‡	1859	C. W. Rinman	44.9	62.0	38.0	0.043	(0.02)		83.1	6.0	2.7	7.8	0.9		46.1-3.9=11.8	
Norrberke:																
Östanberg Smed.*	1861	E. Rinman	46.5	64.2	35.8	3.01	0.06		71.0	7.4	14.2	7.4			40.4-7.0=5.8	
Östanberg Tun et Lang*	1859	G. Hjort af Ornäs	42.3			Trace	(0.7)									10 p.ct.of lime.
Hemgrufva*	1860	A. B. Littorin	42.8			(0.01)	(0.04)									5 p. ct. of lime.

Table showing the analyses of the most important ores and iron of Sweden—Continued.

Name of the mine.	Year of working.	Name of chemist.	Percentages of constituents.						Percentages of constituents of earthy matters.					Oxygen of silicic acid and alumina divided by oxygen of the bases.	Quantity of carbonate of lime or of quartz for the fusion in per cent. of the ore.
			Iron.	Oxide of iron.	Earthy matter.	Phosphorus.	Sulphur.	Other matter.	Silica.	Alumina.	Lime.	Magnesia.	Manganese.		
PROVINCE OF WESTERAS.															
Norberg:															
Risberg—Föreumgs*	1863	T. W. Fagerholm ..	54.3	74.9	25.1	(0.05)	(0.03)	....	92.3	2.7	1.6	1.8	1.6	49.3-1.6=31.8	
Pantzar*	1861	L. Rinman..........	49.1	70.2	29.8	0.022	0.005	....	75.9	1.0	19.4	3.7	0	40.-7=5.7	
Örling‡..................	1861	J. P. Lundberg	49.0	67.7	32.3	(0.03)	(0.05)	....	81.1	3.2	9.8	5.1	0.8	43.7-5.1=8.6	
Svartberg*	1863	H. Klint...........	48.1	66.5	33.5	(0.09)	(0.03)	....	89.4	4.5	2.7	2.4	1.0	48.0-2.3=21.3	
Lilla Ny*.................	1864	P. Edman	31.7	43.8	56.2	(0.02)	(0.03)	....	56.5	8.5	22.5	12.5	....	33.4-11.5=2.9	
Hülphers..................	1864	A. Westerberg......	48.9	67.5	32.5	(0.05)	(0.03)	....	89.0	4.5	0.2	5.1	1.2	48.4-2.4=20.1	
Flik*.....................	1859	A. F. Groth........	48.7	67.3	32.7	0.016	(0.01)	....	87.9	Trace	7.2	0.8	4.1	45.7-3.4=13.9	
Graurot*	1861	L. Rinman..........	51.7	71.4	17.4	Trace	0	C: 11.2	21.6	0	21.0	18.8	38.6	11.2-22.2=0.5	
Gröndal*	1863	E. Dufva...........	60.5	83.6	16.4	(0.01)	(0.02)	....	35.1	6.7	17.6	13.7	26.9	22.4-16.6=1.4	
Spetals*	1864	B. Fernqvist.......	49.9	71.4	28.6	0.003	0.006	....	89.5	1.7	7.9	0.4	0.5	47.3-2.5=18.8	
Näsberg*	1864	......do	30.1	41.7	38.2	0.018	0.23	C: 20.1	23.6	1.0	60.1	11.9	3.4	12.7-22.5=0.6	
Skinskatteberg:															
Bastnäs: (Riddarhytta)‡....	1859	J. F. Lundberg.....	45.6	65.1	34.9	0.009	(0.02)	....	87.1	4.1	4.3	4.5	Trace........	47.2-3.0=15.7	
Sala: Springar‡	1857	......do	50.2	69.3	27.6	0.012	0.075	C: 3.10	60.1	12.0	20.6	4.7	2.6	36.9-8.4=4.4	
PROVINCE OF ÖREBRO.															
Nya Kopparberg:															
Lomberg: Storbatten*......	1863	C. H. Lundström....	49.9	71.3	28.7	0.076	0.04	....	85.4	8.4	3.9	2.0	0.3	48.3-2.0=24.2	
Svartvik*	1863	......do	48.0	66.3	26.9	0.01	0.05	C: 6.8	36.3	7.8	28.9	17.0	10.0	22.5-17.5=1.3	
Do*	1862	L. Rinman..........	53.2	73.6	21.0	Trace.	0.043	C: 5.4	39.1	4.6	19.4	19.7	17.2	22.5-13.7=1.6	
Ramsberg: Blanka...........	1860	......do	......	......	......	0.014	....	....	......	......	......	......	....	....	
Strassa*	1862	......do	48.9	67.5	32.5	0.004	0.11	....	85.9	7.1	1.8	3.2	2.0	48.0-2.3=21.3	
Linde: Gräushytte Moss*....	1862	......do	55.7	77.0	23.0	0.011	Trace.	....	90.8	4.0	3.0	2.2	Trace........	49.0-1.7=28.0	
Stripa*	1862	......do	59.0	82.9	17.1	0.005	Trace.	....	78.9	2.8	8.9	9.4	Trace........	42.35-6.3=6.7	
Fanthytte: Johannisberg* ..	1854	J. F. Baer	44.0	60.8	35.8	0.019	0.65	C: 3.4	52.4	3.6	14.3	26.0	3.7	28.9-15.3=1.9	

Limnäs Hag*	1862	L. Rinman	30.9	42.7	34.6	0.015	0.13	C: 22.7	13.3	5.5	37.8	33.4	10.0		9 5-26.0=0.4
Hellefors: Björnhöjde*	1859	C. H. Lundström	50.1	69.1	30.9	0.20	0.06		50.9	11.5	23.4	12.3	1.9		31.3-12.0=2.6
Smalkärn*	1863	do	61.6	87.9	12.1	0.012	0.04		60.4	12.0	17.8	5.0	4.8		36.9-8.2=4.5
Grythytte Högborn*	1862	L. Rinman	58.1	80.2	19.8	Trace	0.01		54.4	9.1	21.7	18.3	0.5		30.5-13.6=2.2
Nora Dalkarlsberg—															
Flint‡	1856	do	62.8	86.7	13.3	0.19	0		44 7	19.4	12.0	23.9	0		32.2-13.0=2.5
Herr*	1859	C. L. Rinman	64.1	88.6	11.4	0.057	0		46.3	21.8	12.2	17.5	2.2		34.2-11.1=3.2
Kettil*	1859	do	61.5	84.9	15.1	0.083	0		49.5	17.1	11.5	20.2	1.7		33.7-11.7=2.9
Österry ming*	1859	do	62.2	84.6	15.4	0.05	0.03		45.9	30.8	7.9	13.3	2.1		38.2-8.1=4.7
Fall No. 1	1859	J. F. Lundberg	67.8			(0.043)	(0.02)								
Wiker*	1861	L. Rinman	41.1	56.4	32.1	0.023	0.40	C: 11.5	41.5	7.1	7.4	29.6	14.4		24.9-16.8=1.5
Asboberg*	1866	C. H. Lundström	60.7	86.8	13.1	0.019	0.05		60.6	19.4	10.5	9.1	0.4		41.4-6.7=6.2
Striberg*	1866	C. H. Lundström	50.0	71.4	28.6	0.016	0.04		91.5	1.4	5.5	1.1	0.5		49.4-2.1=23.5
Svartberg*	1866	do	57.8	79.8	21.2	0.007	0.045		73.5	5.6	8.0	10.7	2.2		41.8-7.0=6.0
Klacka and Lerberg*	1863	L. Rinman	60.7	83.9	11.1	0.002	0		75.6	8.5	5.1	9.7	1.1		43.3-5.6=7.7
Hollare: mo*	1862	B. Ferngoirt	68.4	94.5	5.5	Trace	0.05	C: 0.02	55.2	17.2	7.8	19.0	0.8		36.7-9.8=3.7
PROVINCE OF CARLSTAD.															
Filipstad: Nordmark*	1862	C. H. Lundström	55.8	77.1	22.9	0.02	0.025		55.0	4.7	20.5	16.6	3.2		30.7-13.2=2.3
Brattfors*	1863	L. Rinman	59.8	82.6	16.8	Trace	0.012	C: 0.6	56.7	4.1	22.8	13.4	3.0		31.4-12.5=2.5
Taberg 1*	1863	do	53.4	73.8	25.5	0.013	0.05	C: 0.7	59.5	5.6	11.2	23.1	0.6		33.5-12.5=2.7
Taberg st.*	1863	do	56.3	77.7	21.2	0.013	0.05	C: 1.1	57.4	7.2	10.5	23.7	1.2		33.2-12.7=2.5
Eng*	1862	do	56.6	78.2	20.6	0.012	0.03	C: 1.2	46.8	6.1	26.3	17.6	3.2		27.2-15.3=1.8
Age*	1856	Cl. Ullgren	51.2	70.7	29.3	0.028	0.21		54.5	4.5	17.1	20.5	3.4		30.4-13.8=2.2
Tersberg: Stor*	1856	L. Svanberg	53.3	73.4	26.6	0.003	0.03		57.1	11.2	11.9	19.6	0.2		35.7-11.2=3.2
Kran*	1856	do	50.3	69.2	30.8	0.008	0.03		57.1	9.5	14.2	18.1	0.1		35.4-11.3=3.1
Gustaf Adolf*	1865	C. H. Lundström	53.3	73.4	26.6	0.008	0.035		51.0	5.0	21.0	22.3	0.7		25-15=1.7
Ö. Hagen*	1865	do	57.1	78.6	21.4	0.007	0.03		62.7	5.5	13.6	17.7	0.5		35.1-11.1=3.2
Jordaskär*	1863	L. Rinman	59.9	82.7	16.8	0.002	0.016	C: 0.5	55.0	6.0	24.3	12.1	2.6		32.0-12.1=2.6
Langban	1862	do	62.6	89.4	10.6	0.017	0.024		80.8	5.4	5.9	7.9	Trace		45.6-4.8=9.5
Fagerberg*	1862	C. H. Lundström	50.1	69.1	30.9	0.01	0.33	Cu. 0.12	45.3	8.6	32.8	6.2	7.1		27.6-13.4=2.1
PROVINCE OF NYKÖPING.															
Staf‡	1859	L. A. v. Celsing	40.1	55.4	45.6	0.05			78.3	6.1	6.8	5.9	2.9		43.6-4.9=8.8
Skalnirda—Wilhelmina*	1859	C. Wahlund	58.0	80.2	19.8	0.072	(0.03)		49.0	38.2	9.5	Trace	1.8	Ti: 1.5	43.2-3.7=11.7
Elgsjö‡	1862	J. O. Källgren	50.2	69.3	30.7	(0.04)	(0.03)	Cu. trace	84.5	4.0	4.8	4.2	2.5		45.8-3.6=12.7
Förola‡	1858	C. D. Tideström	55.7	76.9	23.1	0.01	(0.06)		90.7	4.1	2.6	0.4	2.2		49.1-1.4=35.0

Table showing the analyses of the most important ores and iron of Sweden—Continued.

Name of the mine.	Year of working.	Name of chemist.	Percentages of constituents.						Percentages of constituents of earthy matters.						Oxygen of silicic acid and alumina divided by oxygen of the bases.	Quantity of carbonate of lime or of quartz for the fusion in per cent. of the ore.
			Iron.	Oxide of iron.	Earthy matter.	Phosphorus.	Sulphur.	Other matter.	Silica.	Alumina.	Lime.	Magnesia.	Manganese.			
PROVINCE OF ÖSTERGÖTLAND.																
Natorp[a]	1860	A. F. Groth	47.1	65.1	34.9	0.016	(0.07)	....	57.5	2.8	32.1	7.1	0.5	....	31.2-12.1=2.6	
Petäng[b]	1858	J. A. M. Siberg	46.7	64.6	35.4	0.01	(0.1)	....	55.5	11.2	18.9	12.8	1.6	....	34.1-10.8=3.1	
Stenebo[b]	1858	M B.,o kman	57.9	80.0	20.0	0.03	(0.09)	....	80.4	9.6	3.2	5.2	1.	....	46.2-3.3=13.8	
PROVINCE OF JÖNKÖPING.																
Taberg[b]	1864	B. Fernqvist	31.2	43.4	54.0	0.056	0.013	Bitumen and H.2.6	39.8	10.4	3.1	34.2	0.75	1:11.	28.1-14.3=2.0	
PROVINCE OF KRONOBERG.																
Langhutt	1865	B. Fernqvist	41.1	56.7	43.3	Trace.	....	....	47.1	18.5	1.9	11.6	0.5	Ti: 20.4	....	

[a] The parenthesis signifies that the analysis for the per cent. of sulphur or phosphorus is made with the regulus of cast-iron, obtained in the small crucible of Sefström's furnace.
[b] Other specimens contain more manganese.

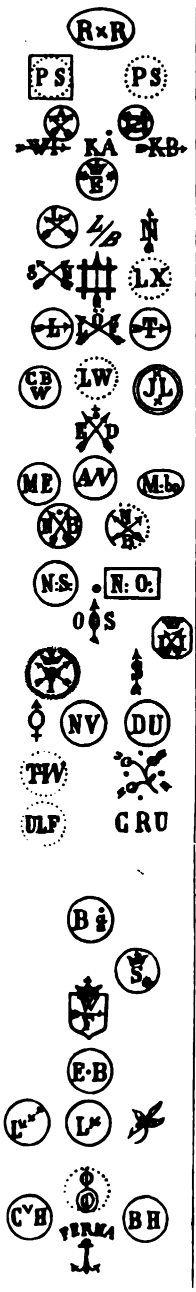
APPENDIX B.

TABLE SHOWING SEVERAL MARKS OF SWEDISH IRONS.

Mark.	Name of works.	Post Office.	Annual production in tons.	Principal ores.
	PROVINCE OF NORRBOTTEN.			
S: B:	Gellivore	Råneå	300	Gellivare.
	PROVINCE OF WESTERBOTTEN.			
HR RH	Hörnefors	Umnea	1,100	From middle of Sweden.
ICP	Olofsfors	Nordmaling	300	Id.
RI AB	Robertsfors	Ånäsen	600	Id.
FSL	Säfvare	Umnea	180	
	PROVINCE OF WESTER NORRLAND.			
CNF	Björkå	Nyland	150	From Lenaberg, Norberg, and Utö.
	Forsse	Nyland	1,400	Id.
	Graninge			
	Sollefteå			
B	Galtström	Sundsvall	380	From Utö, Bispberg, etc.
G	Gideå	Örnsköldsvik	350	
ER	Gåhlsjö	Nyland	170	From Lenaberg, Norberg and Utö.
Lö	Lögdö	Sundswall	175	From Stochenström, Utö, etc.
MF PD	Matfors	Id	200	
	Norafors	Id	175	From Staf.
CH B NG	Sörfors, etc.	Id	600	From Roslag.
TH	Torpshammar	Id	230	
L	Westtanå	Hernösand	340	
LP	Åviken	Sundswall	130	

Mark.	Name of works.	Post Office.	Annual production in tons.	Principal ores.
	PROVINCE OF GEFLEBORG.			
SM	Andersfors	Hudikswall	150	
	Axmar	Gefle	1,100	From Utö, Enkärn, etc.
B E	Forsbacka, (for steel)	Gefle	850	From Tuna, Hartberg, etc.
HG	Gamelstilla	Thorsåker	430	From Bispberg, Norberg, and Thorsåker.
O	Grönzinka	Gysinge	440	From Norberg, etc.
B	Gysinge	Id	940	From Dannemora.
HG E: P: HP VP CP RP RP	Hammarby; Kungsfors and Uhrfors; Hofors; Montros; Robertsholm	Thorsåker	2,300	From Bispberg, Norberg, and Thorsåker.
DE & C:o	Högbo and Sandviken	Gefle	....	From Bispberg and Thorsåker.
R W-n CR	(For gun-barrels.) Kihlafors (For steel.)	Söderhamn	1,100	From Hammarim and Norberg.
	Ljusne	Id	430	From Norberg, Utö, Striberg, Dannemora, etc.
ST LB	Långvind	Id	680	From Wigelsbo, Utö, and Herräng.
	Mackmyra	Gefle	370	
	Orkelbo	Id	1,500	From Vintjern.
T BM	Oslättfors	Id	600	From Bispberg, etc.
	Ström	Hudikswall	720	From Östanberg, etc.
Sv	Svabensverk	Falun	550	From Vintjern.
	Tolffors	Gefle	260	From Bispberg.
WB	Woxna	Bollnäs	630	From Gymås and Sörskog.

Mark.	Name of works.	Post Office.	Annual production in tons.	Principal ores.
	PROVINCE OF UPSALA.			
	Elfkarleö	Tierp	430	From Dannemora.
	Gimo	Upsala	280	Id.
	Leufsta	Tierp	700	Id.
	Strömsberg	Id	450	Id.
	Söderfors	Id	850	Id.
	Wattholma	Upsala	255	Id.
	Österby	Id	1,500	Id.
	PROVINCE OF STOCKHOLM.			
	Forsmark	Tierp	520	From Dannemora.
	Skebo	Norrtelje	830	Id.
	Harg	Östhammar	430	Id.
	Rånås	Stockholm	230	Id.
	PROVINCE OF STORA KOPPARBERG.			
	Avesta	Avesta	180	
	Dalfors	Gagnef	470	From Hamsart, Sörskog, and Gymås.
	Dådran	Falun	350	From Vinjern and Skinnaräng.
	Fredriksberg	Gagnef	1,100	From Byberg and Grängesberg.
	Fredshammar	Mora	770	From Åhl, etc.
	Farudal	Gagnef	650	From Åhl and Harmsarf.
	Garpenberg	Avesta	860	From Bispberg and Långvik, etc.
	Gravendal	Gagnef	1,100	From Grängesberg.
	Grängshammar	Säter	1,100	From Gräsberg, etc.
	Hagge	Snedjebacken	1,400	From Grängesberg.
	Horndal	Avesta	510	From Bispberg, etc.
	Kloster	Hedemora	940	From Rällingsberg.



Mark.	Name of works.	Post Office.	Annual production in tons.	Principal ores.
	Kloten and Granhult	Köping or Ramsberg	980	From Grängesberg, Lomberg, and Ramsberg.
	Korså and Svartnäs	Falun	1,600	From Vintjern and Skinnaräng.
	Larsbo	Smedjebacken	600	From Ostanberg, Norberg.
	Limå and Noraå	Gagnef / Falun	280	From Tuna Hästberg.
	Lindesnaes	Gagnef	1,500	From Gräsberg.
	Snöå	Gagnef	900	From Sommarberg, etc.
	Ludvika	Smedjebocken	1,600	From Ivike, Främmundberg, Finnås and Håksberg.
	Långö	Mora	270	
	Malingsbo	Wik	510	From Grängesberg, etc.
	Norn	Hedemora	280	From Bipsberg.
	Norså and Olofsfors	Smedjebocken	230	
	Nyhammar	Id.	1,600	From Grängesberg and Ivike.
	Siljansfors	Mora	280	From Sörskog, etc.
	Stjernsund	Hedemora	280	From Bispberg and Norberg.
	Thurbo and Wikmanshyttan (Cast steel.)	Hedemora	760	From Bispberg and Norberg
	PROVINCE OF WESTERÅS.			
	Baggå	Köping	470	From Gräsberg and Nyberg.
	Berntshammar	Id.	410	
	Bjurfors	Norberg	270	From Norberg.
	Engelsberg	Id.	320	Id.
	Fagersta	Id.	1,200	Id.
	Ferna	Köping	1,700	From Gräsberg, Nyberg, and Grängesberg.

Mark.	Name of works.	Post Office.	Annual production in tons.	Principal ores.
	Gislarbo	Köping	900	From Riddarhytta.
	Hallstahammar	Strömsholm	450	
	Högfors and Persbo	Norberg	250	From Norberg.
	Jäder	Arboga	280	
	Karmansbo, etc.	Köping	1,300	From Norberg and Grängesberg.
	Kolsva	Köping	1,200	From Stripa, etc.
	Ramnäs	Westerås	940	From Östanberg, etc.
	Seglingsberg	Id.	430	From Norberg.
	Skattmansö	Enköping	260	
	Skinnskatteberg	Köping	680	From Billsjö and Norberg.
	Surahammar	Westerås	1,400	From Norberg.
	Svanå	Id.	760	Id.
	Trångfors	Strömsholm	190	
	Uttersberg	Köping	340	From Gräsberg, Tyskgrafva, etc.
	Westanfors	Norberg	190	From Norberg.
	Wirsbo	Westerås	430	
	PROVINCE OF ÖREBRO.			
	Aspa	Askersund	490	From Nora.
	Bofors	Carlskoga	1,000	From Persberg and Nora.
	Bohr	Lindesberg	160	From Lomberg, etc.
	Bredsjö	Nora	170	From Örjöberg, Gröndal, etc.
	Brefven	Kilsmo W. S. B.	350	From Nora and Lanna.
	Bångsmedjan	Nya Kopparberg	140	From Lomberg, etc.

Mark.	Name of works.	Post Office.	Annual production in tons.	Principal ores.
K	Degerfors Ö	Åtorp	150	From Dalkarlsberg and Striberg.
WC H	Degerfors N	Begesfors N. W. S. B.	850	From Persberg, Dalkarlsberg, Striberg, & Viker.
K	Elfstorp	Nora	790	From Högborn.
PF	Frötuna	Arboga	390	
GD	Common marks. Gammelbo	Company of Gammelbo. Ramsberg	270	From Ramsberg and Pershytta.
G	Finnåker	Arboga	1,050	
WF	Grönbo	Id	220	
D R	Ramshytta	Nora	120	
GB	Garphyttan	Örebro	260	From Pershytta and Mografva, etc.
HH AH	Gryn	Pålsboda W. S. B.	1,020	From Nora.
V	Haddebo Ö	Id	210	Id.
PW B	Haddebo N	Id	290	Id.
	Hammarby	Nora	1,000	From Hagby, Lerberg, etc.
MF W	Hasselfors	Hasselfors N. W. S. B.	600	From Dalkarlsberg, Striberg and Viker.
H HS LS1 C	Hellefors	Grythyttehed	2,810	From Lomberg and Svartvik, etc.
NE	Högfors	Nya Kopparberg	120	Id.
S×L L	Lassåna	Laxå W. S. B.	430	From Nora.
HSH	Laxå	Id	850	From Dalkarlsberg, Striberg, and Viker.
	Petersfors	Nora	150	From Jernboås.
	Ramsberg	Ramsberg	150	From Stråssa and Blanka.
PV	Ramshytta	Id	140	Id.
K·	Rockesholm	Nora	260	From Skärhytta and Högborn.
	Rockhammar	Arboga	1,050	From Stripa, Mossgrufva etc.
	Sikfors	Grythyttehed	150	From Finnberg, etc.
CWS Mn	Skogaholm	Pålsboda W. S. B.	510	From Nora.
	Skyllberg	Hallsberg W. S. B.	800	From Nora.

Mark.	Name of works.	Post Office.	Annual production in tons.	Principal ores.
	Stjernfors	Nya Kopparberg	470	From Lomberg and Svartvik, etc.
	Svartå	Svartå N.W.S.B	700	From Dalkarlsberg, Striberg, Viker, & Persberg.
	Walåsen	Carlskoga	360	Id.
	Willingsberg	Örebro	500	Id.
	Wrethammar	Ramsberg	130	From Stråssa and Blanka.
	Åbyhammar	Arboga	170	
	PROVINCE OF SKARABORG.			
	Forsvik	Karlsborg	300	From Nora
	Fredriksfors	Wassbacken	270	Id.
	Lagerfors	Moholm W.S.B.	300	Id.
	Ribbingsfors	Mariestad	350	Id.
	Skagersholm	Finnerödja W. S. B.	430	Id.
	PROVINCE OF CARLSTAD.			
	Ackhärn	Christinehamn	550	From Filipstad.
	Bada Ö	Sunne	150	Id.
	Björneborg and Jonsbol	Christinehamn	1,000	From Persberg, Dalkarlsberg, Streberg, & Viker.
	Borgvik and Brunsberg	Carlstad	2,000	From Persberg.
	Brattfors, etc.	Id.	850	Id.
	Charlottenberg	Arvika	400	From Persberg and Nora.
	Dömle	Carlstad	470	From Filipstad.
	Edsvalla	Id.	940	Id.
	Elfsbacka	Carlstad	1,280	From Nordmark and Finshytta.
	Fredros	Arvika	425	
	Glasfors	Ökne	340	
	Gustafström	Grythyttehed	550	From Persberg, Björnhöjde, Fagerberg, and Långvan.
	Helybodafors	Arvika	160	

Mark.	Name of works.	Post Office.	Annual production in tons.	Principal ores.
K:	Håkanbol	Åtorp	230	From Dalkarlsberg.
CH KB PS	Högfors	Sunne	630	
BE UvA	Kolsäter	Ökne	210	
J.S OPS/C	Krontorp	Christinehamn	370	
RF, GF, IE, UF.	Lennartsfors	Ökne	800	
LP GE	Lesjöfors	Filipstad	1,200	From Långban and berg.
NM JCA CGO	Lethafors	Råda	220	
K: P.G	Lidefors Ö	Åtorp	150	From Dalkarlsberg Striberg.
K: OL	Lidefors N	Id	160	Id.
S:H LNS	Lindfors	Carlstad	850	From Persberg.
OAS MM	Löfstaholm	Sunne	280	
MFS	Mitandersfors	Id	200	
OK MB	Mölnbacka	Carlstad	850	From Persberg.
GL Nm	Niclasdam	Christinehamn	280	
INN	Noreborg	Arvika	140	
HK N	Norum	Carlstad	150	
Q	Qvarntorp	Id	170	
I GG	Ransäter Ö	Id	160	
F EF	Ransäter M	Id	180	
HK CGG	Ransäter N	Id	160	
RD RH CS	Rottnedal	Sunne	640	
6 LD 6	Rämen or Liljendal	Filipstad	680	From Långban, Pers and Filipstad.
IL Ł CIG SB	Storfors	Christinehamn	1,530	From Persberg and kroppa.
HK	Stömned	Carlstad	260	
CÜ ÜG	Svaneholm	Åmål	460	From Filipstad.

Mark.	Name of works.	Post Office.	Annual production in tons.	Principal ores.
WR RF	Sälboda	Arvika	1,230	From Persberg.
	Thorsby	Sunne	630	
LB ÆB G.F OF W.F	Uddeholm	Råda	4,300	From Taberg, Nordmark, Persberg and Långban.
OPS	Wassgårda	Christinehamn	230	
	Wägsjöfors	Sunne	170	
	PROVINCE OF ELFSBORG.			
BF	Bäckefors	Åmål	1,520	From Persberg.
CD LF	Christinedal	Id	460	
IGE AL GM	Forsbacka	Id	390	
KB	Kollerö	Uddevalla	700	
V	Upperad	Wenersborg	320	
	PROVINCE OF NYKÖPING.			
F	Forsa	Katrineholm W. S. B.	260	
Z	Forssjö	Id	310	From Skalunda, etc.
K	Krämbol	Id	230	
Ny	Nyby	Thorshälla	340	
	Nyköping	Nyköping	630	
	Skepsta (steel)	Björnlunda W. S. B.	350	
	Smedstorp	Malmköping	170	From Staf.
GS W	Virå	Norrköping	260	
	PROVINCE OF ÖSTERGÖTLAND.			
B R	Borggård	Tjellmo	260	
I B	Borkhult	Söderköping	190	From Utö, etc

Mark.	Name of works.	Post Office.	Annual production in tons.	Principal ores.
B b	Boxholm	Boxholm	640	
B	Börggjöl	Norrköping	160	
F: G; T GE; N: G	Finspong	Id	2,200	From Upsala, Stribe Utö, etc.
C: F:	Folkström	Tjellmo	510	
	Godegård	Hallsberg W. S. B.	270	From Nora and Sansa.
C D B	Grytgjöl	Tjellmo	180	
H	Hult	Norrköping	250	
	Håfla	Id	600	From Nora.
	Hättorp	Tjellmo	170	
	Ljung	Linköping	550	
L	Lemneå	Tjellmo	310	
MW	Motala Werkstad	Motala	2,100	
S-C	Skönnarbo	Tjellmo	380	
.m.	Sonstorp	Norrköping	550	
	PROVINCE OF CALMAR.			
Am	Ankarsrum	Westervik	830	From Stenbo, Narto Sjösa, Herräng, and N berg.
E	Ed	Söderköping	280	From Stenbo, Herrä Utö, and Nartorp.
HB	Falsterbo	Westervik	260	From Skramstad, Öbal and Utö.
	Fogelfors	Staby	310	From Striberg and Sa sta.
T	Tofverum	Wimmersby	170	
	Öfverrum	Åtvidaberg	350	From Sjösa, Utö, Ste näs, Olofsrum, etc.

Mark.	Name of works.	Post Office.	Annual production in tons.	Principal ores.
	PROVINCE OF JÖNKÖPING.			
PI	Eckersholm	Jönköping	140	From Taberg.
:Æ:	Göthafors	Id.	180	Id.
Æ:	Hörle	Wernamo	390	Id.
LF: :Æ: LFN	Lindefors	Wrigstad	290	Id.
NF: NFN	Nissafors	Jönköping	370	From Taberg and Nora.
	PROVINCE OF KRONOBERG.			
AB	Böksholm	Wexiö	160	
KS	Klafreström	Id.	150	
D.S. L.B.	Lessebo	Id.	240	
OF	Orrefors	Id.	240	
SF	Stenfors	Id.	210	
S S S	Säfsjöström	Id.	190	

For information as to the prices and qualities of the irons, one can write directly to the forges themselves. For example: "Brukskontoren à Säfsjöström, Wexiö, Sweden;" or: "Brukskontoret à Nissafors, Jönköping, Sweden," etc.

But as all the marks are not indicated here, and since all the forges have agents, it will be better to ask the name of their agent, who will be able to give all the necessary information.

APPENDIX C.

LUNDIN'S FURNACE.

The following table shows the results for the first year of working of the saw-dust heating furnace, at Munkfors during the year 1866, compared with the results obtained from the charcoal furnaces of the Society of Uddcholm. The two coal furnaces served at the same time as reserves, and have only been worked when the other was under repairs. During the first six months the yield was 789 tons of bar iron, and in the last six months 1,013 tons, of which 557 tons was during the last three months, or at the rate of 2,229 tons per year.

The column containing the consumption of carbon of wood not coked per ton is calculated on the assumption that a cubic foot of charcoal contains eight pounds of pure carbon, and that 50 per cent. of the richness of the wood in carbon is lost in coking. The column shows, therefore, the real consumption of carbon per ton of iron made.

In comparing the consumption of fuel in the saw-dust furnace with that of the charcoal furnaces, it will be seen that the first was able to heat three hundred weight of iron with the same quantity of combustible that the latter would have required for one hundred weight. and this though the former works with wet fuel.

The latest results of the saw-dust furnace are as follows: From November 10, 1866, to April 18, 1867, or during 105 days of 24 hours, a yield of 926 tons of bar iron, with a waste of 12.04 per cent., and with 268 cubic feet saw-dust per ton of iron. One week showed a yield of 56.18 tons, with 219 cubic feet per ton, the waste being only 9.9 per cent. At present the waste does not exceed 11 per cent. (April, 1867.)

Table showing the results of the working of the saw-dust furnace at Munkfors during the year 1866, *comparatively, with the results obtained from the charcoal furnaces of the Society of Uddcholm.*

Year of operation, 1866.	Time in days (24 hours) and hours.	Loops, tons.	Iron detached from the loops and ends cut from bars, tons.	Iron drawn into bars, tons.	Waste, per cent.	Consumption, per ton.				Maximum yield of a single furnace per week, tons.
						Cubic feet saw-dust.	Cubic feet charcoal.	Pounds of wood not coked.	Hours.	
Saw-dust furnace at Munkfors.	206. 11	1, 839. 96	104. 99	1, 532. 30	11. 77	274	......	836	0. 31	57. 59
Two charcoal furnaces at Munkfors......	47. 2	325. 62	18. 20	269. 94	12. 19	......	133	2, 134	0. 83	20. 64
Sum.	253. 13	2, 165. 58	123. 19	1, 802. 24	......	......	......	......	.....	....
Charcoal furnace at Stjernfors..	263. 8	1, 024. 08	54. 12	885. 90	12. 18	......	157	2, 530	0. 75	23. 29
Charcoal furnace at Gustafsfors	284. 4	1, 076. 77	46. 68	893. 53	13. 26	......	168	2, 706	0. 75	22. 22
The preceding four years, average—										
Charcoal furnace at Munkfors	274. 21	1, 067. 72	54. 35	889. 87	12. 19	......	133	2, 134	0. 75	23. 34
Charcoal furnace at Stjernfors	259. 1	949. 35	41. 22	793. 08	12. 66	......	166	2, 662	0. 78	23. 04
Charcoal furnace at Gustafsfors..................	264. 9	1, 008. 65	47. 80	836. 97	12. 89	......	157	2, 530	0. 75	22. 66

EXPLANATION OF LUNDIN'S FURNACE.

Plate I.

All the parts of the furnace are easy to manage, and all the work is regular and solid. The reheating furnace is rarely repaired oftener than every five or six weeks; the repairs only require one or two days at most. The most frequent are only the upper portions of the regenerators, which require to be changed. The condenser is only opened and examined two or three times per year. The gas generator is not cleaned during the week, unless this precaution is rendered necessary by the use of impure saw-dust, or dust mixed with sand; and, in any case, this presents no obstacle to the work. Usually the cinders formed during the week are piled at the side of the neighboring wall every Saturday evening when the work is finished, and it is not necessary to undertake a careful cleaning or to remove the refuse, except when the generators are prepared. The tube of the conduit between the gas generator and the condenser requires to be cleaned every week; but this cleaning, which can be easily made during the working of the furnace, does not prevent the heating. Also, generators of a larger size require cleaning much less often.

SUPPLEMENT BY LUNDIN.

a. This is only the hygroscopic value of the water. Dust containing a larger quantity of water may be employed. Fresh dust often contains 50 per cent. That containing 60 per cent. cannot be used long alone, (this makes 80 per cent. by the addition of the chemical water,) but, mixed with pieces of wood or with good dust, it may be employed with advantage.

b. The quantity of carbonic acid may be removed by the use of quick-lime in the condensing water. The lime may subsequently be used for agricultural purposes, but the effect of the acid is seldom considerable.

c. The auxiliary furnace has worked since January, 1866, from the same generators and condensers which belong to the heating furnace. At present 21 to 28 cubic feet of saw-dust are consumed for the heating and incandescence of a hundred-weight of iron in bars. In the charcoal gas furnace 10½ to 13 cubic feet of coal are employed, and sometimes more. Consequently, the real consumption of carbon in the latter is 100 pounds to one hundred-weight per hundred-weight of iron, on account of the loss by the burning of the wood.

d. The two or three upper layers of the generators of the heating furnace must ordinarily be renewed every four or six weeks, but the other layers, as well as the regenerators in the auxiliary furnace, last much longer.

y, z. Tube for the water which cools the gas by means of eight streams having a diameter of ½ inch. The jets are broken against points of copper

directed towards the centre of the openings of the jets. The pressure of the gas in all the conduits is $\frac{1}{8}$ inch of water.

Condenser of cast-iron plates.—This contains 3,700 pounds of iron, in bars, kept cool by water from the pipe *y y*, in order to cool the gas and precipitate the water. Fifteen and a half gallons of water, heated to 30° Centigrade, flow in a minute when working with the reheating furnace alone. Nearly double will be required when working with the auxiliary furnace at the same time.

Thirty-six gallons of tar are collected per week.

The tube *y y* turns back and forward by an angle of 120°, to wet the bars, situated below, by means of small holes.

Reheating furnace with Siemens' regenerators.—The furnace may be placed at a long distance from the condenser. The temperature calculated from the cold air used to burn the gas is about 2,000° Centigrade.

The following shows the composition of the gas, which is the same before and after the condensation:

Constituents of the gas.	Volume.	Weight.
Carbonic acid	11.8	19.6
Carbonic oxide	19.8	20.8
Hydrogen	11.3	0.87
"Marsh gas"	4.0	2.4
Nitrogen	53.1	56.3

The mixture before condensation contains 33 parts by weight of water to 100 of dry gas. (For other details, see explanations upon the plate.)

APPENDIX D.

RESULTS OF EXPERIMENTS BY DAVID KIRKALDY ON BESSEMER STEEL AND SWEDISH IRON.

General abstract of the results of experiments to ascertain the mechanical properties of eleven bars of billet iron from the Degerfors Iron Works, Sweden.

	PULLING STRESS: LENGTH = NINE DIAMETERS.							THRUSTING STRESS: LENGTH = ONE DIAMETER.					BENDING STRESS: DISTANCE BETWEEN SUPPORTS = 20 INCHES.								
Brand.	Test number.	Elastic stress per square inch.	Ultimate stress per square inch.	Ratio of elastic to ultimate.	Contraction of area at fracture.	Ultimate permanent extension.	Effects.	Test number.	Ultimate stress per square inch.	Ultimate permanent depression.		Effects.	Test number.	Elastic stress.	Ultimate stress.	Ratio of elastic to ultimate.	Deflection with 2,000 lbs. pr. BD^2.	Elastic stress. $\frac{}{B\,D^2}$	Ultimate stress. $\frac{}{B\,D^2}$	Value of S. $S=\frac{L\,W}{4\,B\,D^2}$	Effects.
+	B	*Lbs.*	*Lbs.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*		B	*Lbs.*	*Inch.*	*Pr. ct.*		B								
H..	1617	20,500	43,032	47.6	71.7	40.0	Fractured very slowly.	1598	100,000	.323	28.6	Bulged, uncracked.	1621	7,250	15,404	47.1	2.26	1,057	2,246	11,230	Uncracked;—bent 5 inches.
H..	1597	19,500	42,624	45.8	73.6	42.7	....do.....	1608	100,000	.327	29.0	....do.....	1616	7,250	15,412	47.0	2.32	1,057	2,247	11,235	Do.
H..	1607	19,000	42,528	44.7	72.7	40.5	....do......	1618	100,000	.329	29.2	....do.....	1606	7,100	15,110	46.9	2.58	1,034	2,203	11,015	Do.
H..	1622	19,000	41,548	45.7	73.6	40.2	....do......	1623	100,000	.335	29.7	....do.....	1596	6,950	14,890	46.7	2.66	1,013	2,176	10,855	Do.
		19,500	42,433	45.9	72.9	40.8			100,000	.328	29.1			7,138	15.204	46.9	2.46	1,040	2,217	11,084	
AW	1323	18,500	41,832	44.2	69.8	40.8	....do......	1324	100,000	.328	29.1	....do.....	1312	7,200	15,616	46.1	2.15	1,049	2,276	11,380	Do.
AW	1313	18,000	41,924	43.0	67.8	38.1	....do......	1314	100,000	.347	30.7	....do.....	1322	7,050	15,060	46.7	2.44	1,028	2,196	10,980	Do.
		18,250	41,878	43.6	68.8	39.5			100,000	.338	29.9			7,125	15,338	46.4	2.30	1,038	2,236	11,180	
WC	1293	20,000	44,532	44.9	55.8	31.5	....do......	1299	100,000	.320	28.3	....do.....	1287	7,200	15,728	45.8	1.88	1,049	2,293	11,465	Do.
WC	1298	19,750	43,780	45.1	75.4	40.0	....do......	1294	100,000	.328	29.1	....do.....	1292	6,780	15,320	44.2	2.37	988	2,234	11,170	Do.
WC	1303	18,000	42,048	42.8	73.6	41.2	....do......	1304	100,000	.348	30.8	....do.....	1297	6,500	15,256	43.2	2.45	947	2,224	11,120	Do.
WC	1288	18,500	40,272	45.9	74.5	39.6	....do......	1289	100,000	.351	31.1	....do.....	1302	6,400	15,020	42.6	2.50	933	2,189	10,945	Do.
WC	1308	17,750	40,096	44.2	66.8	36.4	....do......	1309	100,000	.370	32.8	....do.....	1307	6,250	14,318	43.6	3.14	911	2,087	10,435	Do.
		18,800	42,145	44.6	69.2	37.7			100,000	.343	30.4			6,626	15,128	43.8	2.47	965	2,205	11,026	

DAVID KIRKALDY.

GROVE, SOUTHWARK STREET, LONDON, S. E., *July* 20, 1867, Messrs. A. FRODING & Co., *Gothenburg, Sweden*, per Mr. S. H. LUNDH, 9B, *New Broad street, London.*

Results of experiments to ascertain the resistance to extension, set, and rupture, under a pulling stress, and to permanent depression under a thrusting stress, of four Fagersta steel wire billets, manufactured by Christian Aspelin, esq., Sweden.

PULLING STRESS.

Test number.	Billets stamped.	Description.	ORIGINAL.		STRESS IN POUNDS PER SQUARE INCH.—EXTENSION AND SET, INCH.																			
			Diam.	Area.	20,000.	21,000.	22,000.	23,000.	24,000.	25,000.	26,000.	27,000.	28,000.	29,000.	30,000.	31,000.	32,000.	33,000.	34,000.	35,000.	36,000.	37,000.	38,000.	39,000.
B.																								
1405........	0.1	Turned down and polished.	1.128	1.0000	.040 Set.	.041	.043	.044	.045	.047	.048	.050	.052	.054	.056	.057	.058	.059	.060	.062	.063	.064	.066	.067
1404........	0.1	....do	1.128	1.0000	.040 Set.	.042	.043	.044	.046	.047	.048	.049	.050	.052	.053	.055	.057	.058	.060	.062	.064	.071	.084 .018	.132
1403........	0.1	....do	1.128	1.0000	.040 Set.	.042	.044	.046	.048	.051	.058	.065	.070	.078	.087	.108	.143	.173	.218	.251	.303	.332	.391	.484
1406........	0.1	....do	1.128	1.0000	.036	.037	.038	.042	.050 .010	.060	.010 0.71 .028	.088	.020 .102 .051	.118	.038 .138 .082	.167	.080 .215 .180	.269	.158 .304 .234	.335	.238 .398 .332	.429	.324 .50[illegible] .432	.542

Test number.	STRESS IN POUNDS PER SQUARE INCH.—EXTENSION AND SET, INCH.														Ultimate stress per sq. inch of original area.	FRACTURED.				Ultimate stress per sq. inch of fractured area.	EXTENSION.	
																Diam.	Area.	Difference.			Total.	Per cent.
	40,000.	41,000.	42,000.	43,000.	44,000.	45,000.	46,000.	47,000.	48,000.	49,000.	50,000.	51,000.	52,000.	53,000.				Area.	Per cent.			
B.															*Pounds.*	*Inch.*	*Sq. inch.*	*Sq. inch.*		*Pounds.*	*Inch.*	
1405........	.069	.070	.071	.072	.073	.139 .059	.150 .073	.166	.191 .111	.217	.261 .173	.291	.360 .261	.401	53,924	.61	.2922	.7078	70.78	184,545	1.08	10.8
1404	.146 .070	.166	.196 .124	.220	.254 .176	.293	.347 .268	.380	.458 .376	.521	.666 .577	.866	......	......	51,640	.57	.2552	.7448	74.48	202,351	1.61	16.1
1403	.518 .446	.568	.653 .576	.748	.868 .788	1.04	1.25 1.15	1.56	......	......	......	......	......	......	47,392	.58	.2642	.7358	73.58	179,380	2.10	21.0
1406........	.650 .577	.720	.832 .752	.935	1.10 1.02	1.31	1.65 1.56	......	......	......	......	......	......	......	46,896	.57	.2552	.7448	74.48	183,761	2.51	25.1

Results of experiments to ascertain the resistance to extension, set, and rupture, under a pulling stress, &c.—Continued.

THRUSTING STRESS.

Test number.	Billets stamped.	Description.	ORIGINAL. Height.	ORIGINAL. Diameter.	ORIGINAL. Area.	STRESS IN POUNDS PER SQUARE INCH.—PERMANENT DEPRESSION, INCH. 36,000.	44,000.	52,000.	60,000.	68,000.	76,000.	84,000.	92,000.	100,000.	108,000.
B			*Inch.*	*Inch.*	*Square inch.*										
1401	0.1	Turned down and polished	1.127	1.128	1.0000	.000	.023	.049	.079	.124	.168	.208	.242	.280	.320
1402	0.1	......do............do	1.126	1.128	1.0000	.008	.029	.054	.086	.128	.164	.203	.236	.276	.317
1399	0.1	......do............do	1.127	1.128	1.0000	.009	.030	.059	.089	.131	.169	.209	.250	.290	.328
1400	0.1	......do............do	1.124	1.128	1.0000	.010	.031	.063	.097	.141	.182	.222	.260	.300	.340

Test number.	STRESS IN POUNDS PER SQUARE INCH.—PERMANENT DEPRESSION, INCH. 116,000.	124,000.	132,000.	140,000.	148,000.	156,000.	164,000.	172,000.	180,000.	188,000.	196,000.	Ultimate stress per square inch.	Ultimate permanent depression.		Remarks.
B												*Pounds.*	*Inch.*	*Per cent.*	
1401	.360	.392	.420	.442	.466	.488	.505	.528	.546	.560	.578	200,000	.580	51.4	Uncracked.
1402	.356	.385	.412	.436	.460	.482	.500	.519	.535	.550	.568	200,000	.570	50.6	Ditto.
1399	.367	.394	.421	.452	.476	.500	.520	.543	.558	.572	.590	200,000	.593	52.6	Ditto.
1400	.378	.413	.440	.462	.487	.502	.522	.545	.558	.571	.589	200,000	.592	52.7	Ditto.

DAVID KIRKALDY.

GROVE, SOUTHWARK STREET, LONDON, S. E., *June* 1, 1867.

CHRISTIAN ASPELIN, Esq., *Norberg and Fagersta, Sweden.*
Agent, Mr. S. H. LUNDH, 9B, *New Broad Street, London.*

General abstract of the results of experiments to ascertain the mechanical properties, &c., of twelve hammered bars of Fagersta steel of various degrees of hardness, manufactured by Christian Aspelin, esq., Sweden.

	PULLING STRESS: LENGTH = NINE DIAMETERS.							THRUSTING STRESS: LENGTH = ONE DIAMETER.					
Bars stamped.	Test number.	Elastic stress per square inch.	Ultimate stress per square inch.	Ratio of elasticity to rupture.	Contraction of area at fracture.	Ultimate permanent extension.	Effects.	Test number.	Elastic stress per square inch.	Ultimate stress per square inch.	Ultimate permanent depression.		Effects.
	B	*Lbs.*	*Lbs.*	*Per ct.*	*Per ct*	*Per ct.*		B	*Lbs.*	*Lbs.*	*Inch.*	*Per ct.*	
1.2	1068	63,000	81,952	76.8	3.23	1.7	Fractured suddenly	1070	65,000	200,000	.278	24.6	Bulged.
1.2	1078	60,000	81,424	73.7	1.48	1.4	....do	1080	63,000	200,000	.215	19.0	Ditto.
1.2	1088	63,500	92,224	68.8	3.23	2.2	....do	1090	64,000	200,000	.216	19.1	Ditto.
		62,167	85,200	73.1	2.65	1.8			64,000	200,000	.236	20.9	
0.9	1098	63,000	112,976	55.8	4.97	3.7	....do	1100	65,000	200,000	.222	19.7	Ditto.
0.9	1108	63,000	109,952	57.3	8.39	7.9	....do	1110	63,000	200,000	.265	23.5	Ditto.
0.9	1118	63,000	96,912	65.0	4.97	3.6	....do	1120	60,000	200,000	.270	23.9	Ditto.
		63,000	106,613	59.4	6.11	5.1			62,666	200,000	.252	22.4	
0.6	1128	63,000	101,232	62.2	21.46	5.5	....do	1130	62,000	200,000	.290	25.7	Ditto.
0.6	1138	53,000	97,968	54.1	10.08	5.7	....do	1140	56,000	200,000	.314	27.8	Ditto.
0.6	1148	58,000	108,696	53.4	11.75	8.7	....do	1150	62,000	200,000	.278	24.6	Ditto.
		58,000	102,632	56.6	14.43	6.6			60,000	200,000	.294	26.0	
0.3	1158	45,000	61,288	73.4	61.52	22.1	Slowly ...	1160	38,000	200,000	.546	48.4	Ditto.
0.3	1168	41,000	63,120	64.9	60.42	16.2	....do	1170	41,000	200,000	.522	46.2	Ditto.
0.3	1178	43,000	59,528	72.2	62.61	11.2	....do	1180	38,000	200,000	.562	49.8	Ditto.
		43,000	61.312	70.3	61.52	16.5			39,000	200,000	.543	48.1	

General abstract of the results of experiments, &c.—Continued.

	THRUSTING STRESS: LENGTH = TWO DIAMETERS.						THRUSTING STRESS: LENGTH = FOUR DIAMETERS.					
Bars stamped.	Test number.	Elastic stress per square inch.	Ultimate stress per square inch.	Ultimate permanent depression.		Effects.	Test number.	Elastic stress per square inch.	Ultimate stress per square inch.	Ultimate permanent depression.		Effects.
	B	*Lbs.*	*Lbs.*	*Inch.*	*Per ct.*		B	*Lbs.*	*Lbs.*	*Inch.*	*Per ct.*	
1.2	1071	65,000	157,920	....	....	Detruded..	1072	63,000	124,260	.486	10.8	Skewed.
1.2	1081	62,000	175,800	....	....	....do	1082	63,000	140,120	.222	4.9	Ditto.
1.2	1091	63,000	176,000	.775	34.4	Skewed ...	1092	61,000	135,610	.492	10.9	Ditto.
		63,333	169,907					62,333	133,333	.400	8.9	
0.9	1101	58,000	184,000	.702	31.2	....do	1102	57,000	135,800	.410	9.1	Ditto.
0.9	1111	59,000	179,860	....	....	Detruded..	1112	59,000	115,880	.390	8.7	Ditto.
0.9	1121	59,000	156,000	.410	18.2	Skewed ...	1122	60,000	100,000	.112	2.5	Ditto.
		58,666	173,287					58,666	117,560	.304	6.8	
0.6	1131	60,000	156,000	.470	20.9	....do	1132	55,000	100,000	.143	3.2	Ditto.
0.6	1141	52,000	156,000	.638	28.4	....do	1142	50,000	100,000	.180	4.0	Ditto.
0.6	1151	60,000	156,000	.442	19.7	....do	1152	55,000	116,000	.422	9.4	Ditto.
		57,333	156,000	.517	23.0			53,333	105,333	.248	5.5	
0.3	1161	43,000	140,000	1.02	45.3	....do	1162	40,000	82,260	.931	20.7	Buckled.
0.3	1171	43,000	124,000	0.92	40.9	....do	1172	40,000	71,920	.502	11.2	Ditto.
0.3	1181	40,000	100,000	.547	24.3	....do	1182	43,000	91,100	1.10	24.4	Ditto.
		42,000	121,333	.829	36.8			41,000	81,760	.844	18.8	

General abstract of the results of experiments, &c.—Continued.

THRUSTING STRESS: LENGTH = EIGHT DIAMETERS.							SHEARING STRESS: ON EACH END OF SPECIMEN.						
Bars stamped.	Test number.	Elastic stress per square inch.	Ultimate stress per square inch.	Ultimate permanent depression.		Effects.	Bars stamped.	Test number.	Shearing stress per square inch.	Pulling stress per square inch.	Ratio of shearing to pulling stress.	Distortion before rupture.	Effects.
	B	*Lbs.*	*Lbs.*	*Inch.*	*Pr. ct.*			B	*Lbs.*	*Lbs.*	*Pr. ct.*	*Inch.*	
1.2	1073	60,000	94,200	.325	3.6	Buckled.	1.2	1074	62,425	81,952	76.2	.192	Fractured.
1.2	1083	63,000	112,320	......	......	Buckled and	1.2	1084	58,050	81,424	71.3	.179	Do.
						then snap-	1.2	1094	63,760	92,224	69.1	.208	Do.
						ped.			61,412	85,200	73.3	.193	
1.2	1093	62,000	100,000	.164	1.8	Buckled.	0.9	1104	82,250	112,976	72.8	.286	Do.
		61,666	102,173				0.9	1114	82,140	109,952	75.6	.222	Do.
0.9	1103	57,000	97,100	.448	5.0	Do.	0.9	1124	74,880	96,912	77.2	.240	Do.
0.9	1113	58,000	92,300	.312	3.5	Do.			79,737	106,613	75.2	.249	
0.9	1123	59,000	96,220	.212	2.4	Do.	0.6	1134	73,910	101,232	73.0	.280	Do.
		58,000	95,207	.324	3.6		0.6	1144	69,985	97,968	70.0	.275	Do.
0.6	1133	54,000	83,000	.342	3.8	Do.	0.6	1154	71,050	108,696	65.4	.288	Do.
0.6	1143	50,000	82,500	.383	4.3	Do.			71,648	102,632	69.5	.281	
0.6	1153	54,000	88,980	.340	3.8	Do.	0.3	1164	43,110	61,288	70.3	.328	Do.
		52,666	84,827	.355	4.0		0.3	1174	49,170	63,120	77.8	.341	Do.
0.3	1163	37,000	47,920	.402	4.5	Do.	0.3	1184	43,950	59,578	73.8	.300	Do.
0.3	1173	43,000	45,500	.442	4.9	Do.			45,410	61,312	74.0	.323	
0.3	1183	42,000	49,120	.460	5.1	Do.							
		40,666	47,513	.435	4.8								

General abstract of the results of experiments, &c.—Continued.

TWISTING STRESS: LENGTH OF LEVER = TWELVE INCHES.—LENGTH FOR TORSION = EIGHT DIAMETERS.

Test number.	Elastic stress per square inch.	Ultimate stress per square inch.	Ratio of elastic to ultimate.	Ultimate torsion.	Effects.
B	*Lbs.*	*Lbs.*	*Per cent.*	1 *turn* = 1.000.	
1069........	1,080	1,849	58.4	0.207 0.220	One end fractured. Other end fractured.
1079........	1,150	2,165	51.3	0.228 0.307	One end fractured. Other end fractured.
1089........	1,175	2,345	50.1	0.375 0.410	One end fractured. Other end fractured.
	1,135	2,120	53.9	0.291	
1099........	1,150	2,478	46.4	0.727 0.770	One end fractured. Other end fractured.
1109........	1,075	2,251	47.8	0.625 0.800	One end fractured. Other end uncracked
1119........	1,150	2,280	50.4	0.897 0.938	One end fractured. Other end fractured.
	1,125	2,336	48.2	0.793	
1129........	1,075	2,188	49.1	0.897 1.255	One end fractured. Other end fractured.
1139........	1,050	2,233	47.0	0.750 1.040	One end fractured. Other end uncracked.
1149........	1,125	2,362	48.9	1.013 1.170	One end fractured. Other end fractured.
	1,083	2,261	48.3	1.021	

General abstract of the results of experiments, &c.—Continued.

TWISTING STRESS: LENGTH OF LEVER = TWELVE INCHES.—LENGTH FOR TORSION = EIGHT DIAMETERS.

Test number.	Elastic stress per square inch.	Ultimate stress per square inch.	Ratio of elastic to ultimate.	Ultimate torsion.	Effects.
B	*Lbs.*	*Lbs.*	*Per cent.*	1 *turn* = 1.000.	
1159........	750	1,478	50.7	{ 3.033 { 3.576	One end fractured. Other end fractured.
1169........	780	1,538	50.7	{ 2.535 { 3.140	One end fractured. Other end uncracked.
1179........	760	1,545	49.2	{ 3.283 { 3.725	One end fractured. Other end partly fractured.
	763	1,520	50.2	3.219	

General abstract of the results of experiments, &c.—Continued.

Bars stamped.	BENDING STRESS: DISTANCE BETWEEN SUPPORTS = TWENTY INCHES.								
	Test number.	Elastic stress, total.	Ultimate stress, total.	Ratio of elastic to ultimate.	Ultimate deflection.	Elastic stress. $\frac{}{\text{B D}^2}$	Ultimate stress. $\frac{}{\text{B D}^2}$	Value of S. $S = \frac{\text{L W}}{4 \text{B D}^2}$	Effects.
	B	*Lbs.*	*Lbs.*	*Pr. ct.*	*Inch.*				
1.2	1075	20,400	30,496	66.9	0.75	2,974	4,446	22,230	Fractured.
1.2	1085	21,200	32,896	69.5	0.72	3,091	4,796	23,980	Do.
1.2	1095	21,800	35,376	61.6	0.87	3,178	5,157	25,785	Do.
		21,133	32,589	66.0	0.78	3,081	4,800	24,000	
0.9	1105	21,800	43,820	50.0	1.46	3,178	6,388	31,940	Do.
0.9	1115	21,200	44,552	47.6	1.62	3,091	6,495	32,475	Do.
0.9	1125	22,100	43,128	51.2	1.38	3,222	6,288	31,440	Do.
		21,700	43,833	49.6	1.49	3,164	6,390	31,950	
0.6	1135	18,800	40,260	46.7	3.15	2,741	5,870	29,350	Do.
0.6	1145	17,800	36,200	49.1	3.56	2,595	5,277	26,385	Uncracked; removed.
0.6	1155	18,400	38,120	48.2	3.22	2,682	5,558	27,790	Do.
		18,333	38,145	48.0	3.31	2,673	5,568	27,840	
0.3	1165	13,700	24,420	56.1	5.22	2,000	3,560	17,800	Do.
0.3	1175	15,200	23,280	65.3	5.05	2,216	3,394	16,970	Do.
0.3	1185	18,400	28,150	65.4	5.05	2,682	4,104	20,520	Do.
		15,767	25,283	62.3	5.11	2,299	3,686	18,430	

DAVID KIRKALDY.

GROVE, SOUTHWARK STREET, LONDON, S. E., *June* 1, 1867.

CHRISTIAN ASPELIN, Esq., *Norberg and Fagersta, Sweden.*

Agent, Mr. S. H. LUNDH, 9B, *New Broad street, London.*

Results of experiments to ascertain the mechanical properties of nine rolled plates of Fagersta steel of various degrees of hardness, manufactured by Christian Aspelin, esq., Sweden.

PULLING STRESS.

Plates stamped.	Test number.	Original size.	Original area.	Total ultimate stress.	Ultimate stress per square inch of original area.	Size of fracture.	Area of fracture.	Difference of fractured area.		Stress per square inch of fractured area.	Total extension.	
	B	*Inch.*	*Sq. in.*	*Lbs.*	*Lbs.*	*Inch.*	*Sq. in*	*Sq. in.*	*Pr. ct.*	*Lbs.*	*Inch.*	*Pr. ct.*
0.9	1198	2.50 × .28	.700	76,800	109,714	2.19 × .25	.548	.152	21.7	130,000	1.57	15.7
0.9	1199	2.50 × .28	.700	74,250	106,071	2.36 × .26	.614	.086	12.3	130,000	0.86	8.6
0.9	1189	2.52 × .27	.680	70,020	102,972	2.35 × .25	.587	.093	13.7	122,475	0.92	9.2
0.9	1188	2.52 × .27	.680	68,010	100,015	2.25 × .24	.540	.140	20.6	122,475	1.35	13.5
0.9	1194	2.50 × .27	.675	65,160	96,533	2.44 × .26	.634	.041	6.1	100,480	0.47	4.7
0.9	1193	2.50 × .27	.675	62,550	92,666	2.45 × .26	.637	.038	5.6	100,480	0.41	4.1
					101,328				13.3	117,653		9.3
0.6	1213	2.50 × .28	.700	70,670	100,956	2.29 × .25	.573	.127	18.1	127,012	1.24	12.4
0.6	1214	2.50 × .28	.700	70,440	100,630	2.24 × .24	.538	.162	23.1	127,012	1.11	11.1
0.6	1204	2.50 × .28	.700	73,280	100,469	2.40 × .26	.624	.076	10.9	125,540	0.68	6.8
0.6	1203	2.50 × .28	.700	67,450	96,357	2.16 × .23	.497	.103	14.7	125,540	1.64	16.4
0.6	1208	2.48 × .28	.694	66,910	96,412	2.20 × .24	.528	.166	24.0	111,218	1.42	14.2
0.6	1209	2.48 × .28	.694	60,880	87,240	2.39 × .26	.621	.073	10.5	111,218	0.69	6.9
					97,011				16.9	121,257		11.3
0.3	1640	2.51 × .25	.627	49,940	79,650	2.03 × .17	.345	.282	45.0	126,484	1.29	12.9
0.3	1639	2.51 × .25	.627	46,820	74,637	2.10 × .20	.420	.207	33.0	126,484	1.92	19.2
0.3	1649	2.51 × .27	.677	47,440	70,074	2.07 × .15	.310	.367	54.2	138,554	1.91	19.1
0.3	1650	2.51 × .27	.677	45,530	67,253	2.12 × .17	.361	.316	46.7	138,554	1.00	10.0
0.3	1645	2.51 × .25	.627	43,415	69,242	2.00 × .17	.340	.287	45.8	125,900	1.27	12.7
0.3	1644	2.51 × .25	.627	40,055	63,884	2.02 × .17	.323	.304	48.5	125,900	1.94	19.4
					70,790				45.5	130,313		15.5

***Results of experiments to ascertain the mechanical properties, &c.*—Contin'd.**

BULGING STRESS.

Stamped.	Test number.	Thickness of plate.	Stress in pounds. Bulged, inch.					Ultimate.	
			5,000.	25,000.	50,000.	75,000.	100,000.	Bulge.	Stress.
	B								
0.9	1202	0.28	.123	.756	1.25	1.60	2.00	2.00	100,000
0.9	1197	0.27	.149	.846	1.42	1.81	2.22	2.59	120,000
								2.30	111,000
0.6	1212	0.28	.145	.759	1.31	1.73	2.14	2.52	120,000
0.6	1207	0.28	.153	.812	1.37	1.80	2.23	2.61	120,000
								2.57	120,000
0.3	1643	0.25	.208	.987	1.74	2.39	....	3.68	99,760
0.3	1648	0.25	.211	1.03	1.77	2.42	....	4.40	98,432
								4.04	99,096

Results of experiments to ascertain the mechanical properties, &c.—Cont'd.

PUNCHING STRESS.

Stamped.	Test No.	Thickness.	Ultimate stress per square inch.		Stamped.	Test No	Thickness.	Ultimate stress per square inch.	
	B					B			
0.9	1201	0.28	78,200	76,320	0.6	1205	0.28	72,200	70,350
0.9	1200	0.28	77,200	76,940				74,217	
0.9	1191	0.27	75,290	74,380	0.3	1651	0.27	53,900	53,150
0.9	1190	0.27	74,330	73,360	0.3	1652	0.27	53,000	52,980
			75,752		0.3	1642	0.25	49,860	49,840
0.6	1216	0.28	77,830	77,220	0.3	1641	0.25	49,420	49,260
0.6	1215	0.28	75,620	75,100				51,426	
0.6	1206	0.28	73,150	71,270					

DAVID KIRKALDY.

GROVE, SOUTHWARK STREET, LONDON, S. E., *June* 1, 1867.

CHRISTIAN ASPELIN, Esq., *Norberg and Fagersta, Sweden.*

Agent, Mr. S. H. LUNDH, 9B, *New Broad street, London.*

APPENDIX E.

TRANSCRIPTS OF PRUSSIAN, FRENCH, AND ENGLISH LAWS, UNDER WHICH CO-OPERATIVE ASSOCIATIONS ARE ORGANIZED.

PRUSSIAN LAW GRANTING CORPORATE RIGHTS TO CO-OPERATIVE ASSOCIATIONS.

We, William, by the grace of God King of Prussia, &c., enact, with the consent of the two houses of our Landtag, as follows:

PART I.—OF THE FORMATION OF THE ASSOCIATION.

SECTION 1. Societies with unlimited membership, whose object it is by the transaction of business in common to enlarge credit, increase the trade, profits, and further the household economy of their members, viz.:

1. Loan and credit unions;
2. Raw material and store unions;
3. Unions for the production and sale of finished wares on a common account, (productive association;)
4. Unions for the purchase of the necessaries of life wholesale and the selling them retail, (consumption associations;)
5. Unions for providing members of such unions with dwelling houses;

Acquire under the conditions hereinafter described the rights designated in the present law as those of "registered associations."

SEC. 2. The requisites to the constitution of such associations are—

1. The drawing up of the statutes in writing.
2. The assumption of a common name, (firma.)

The name of the association must be derived from the object of the undertaking, and have affixed to it the title "registered association."

Neither the names of the members, (associates,) nor those of any other persons, must appear in the name of the association. Every new name must be clearly distinguished from those of any previously existing registered association in the same locality.

SEC. 3. The statutes must contain—

1. The name and seat of the association.
2. The object of the undertaking.
3. The duration of the association in the event of the same being established for a limited period only.
4. The conditions under which members join and leave the association.
5. The amount of the shares of the several associates, and the way in which these shares are paid up.
6. The principle upon which the balance sheet is drawn up and the profits are reckoned, and the way in which the balance sheet is audited.
7. The mode of election and the composition of the managing body,

and the forms under which the members of this body are invested with their full powers.

8. The forms used in convoking the associates.

9. The conditions under which the associates exercise their votes.

10. The subjects which are not decided by a simple majority of the associates present at a general meeting, but which require a larger proportion of votes or other conditions.

11. The forms used by the association in making its announcements, and the public journals in which these announcements are made.

12. The condition that all the associates are jointly and severally liable for the debts of the association, and that this liability extends to the whole of their private estate.

SEC. 4. The statutes of the association must be deposited with the commercial tribunal of the district in which the association has its seat, and be entered in the register of associations, which shall form part of the general commercial register. An extract of the statutes must be published containing the following points:

1. The date of the statute.
2. The name and seat of the association.
3. The object of the undertaking.
4. The duration of the undertaking, if limited to a definite period.
5. The names and domiciles of the managing body.
6. The form in which the announcements of the association are made, and the public journals in which they are made.

At the same time public notice is to be given of the fact that the list of the associates is at all times open to inspection at the tribunal of commerce.

If the statute determines the form in which the managing body gives expression to its resolutions and signs on behalf of the association, this provision is likewise to be made public.

SEC. 5. Before the association has been entered on the register it cannot enjoy the rights of a registered association.

SEC. 6. Every alteration in the statutes must be committed to writing, and notified to the tribunal of commerce by the transmission of a duplicate copy of the resolution passed to that effect by the association.

The same process takes place in regard to a statute when altered as that which took place in regard to the original statute. Its publication is only so far necessary as alterations have been made in the points originally published.

The resolutions of the association have no legal force until they have been entered in the register of the commercial tribunal of the district in which the association has its seat.

SEC. 7. At every commercial tribunal in whose district the association has a branch establishment, the latter must be entered on the register of associations, and the procedure described by sections 4, 5, 6, for the parent association, be observed.

PART II.—OF THE LEGAL STATUS OF THE ASSOCIATES, INTER SE, AND OF THEIR LEGAL STATUS AND OF THAT OF THE ASSOCIATION TOWARDS OTHER PERSONS.

SEC. 8. The legal status of the associates, *inter se*, is determined in the first instance by the statutes. The latter, however, can only in so far deviate from the principles laid down in the following sections as such deviation is expressly declared to be allowable.

In the absence of other stipulations in the statute, gain and loss will be divided amongst the associates per head.

SEC. 9. The rights which the associates enjoy with reference to the affairs of the association, more particularly in regard to the conduct of its business, the examining and auditing of the balance sheet, and the determining the distribution of the profits, are exercised by the totality of the associates in general meeting assembled.

Each associate has a voice at such meetings unless the statutes stipulate to the contrary.

SEC. 10. The registered association can acquire rights and enter into binding engagements; it can become possessed of landed property, or acquire other real rights on such property; it can sue and be sued.

The association is under the ordinary jurisdiction of the tribunal of the district in which it has its seat.

The provisions of the general German Mercantile Code and those of the introductory law of 27th June, 1861, with reference to merchants, apply in a similar manner to the associations in so far as the present law does not constitute exceptions.

SEC. 11. The associates are jointly and severally liable with their entire estate for the debts of the association in so far as, in the event of liquidation or bankruptcy, the property of the association is not sufficient to cover the liabilities.

Whoever enters into an existing association is equally with the other members liable for the engagements entered into by the association before his becoming a member.

Any stipulation to the contrary has no binding force against other persons.

SEC. 12. Private creditors of associates have not got the right to claim, for the satisfaction of their debts, effects, claims, or rights which belong to the estate of the association. Such creditors can only put in an execution, attachment, or distraint upon that which the associate himself has a claim to in the shape of interest or profit, and that which falls to his share upon the winding up of the association.

SEC. 13. The provisions of the foregoing section apply equally to private creditors in favor of whom a mortgage or lien on the property of an associate has accrued in virtue of legal proceedings; such mortgage or lien not extending to the effects, claims, or rights which form part of the estate of the association, but being confined to that which was specified in the last paragraph of the foregoing section.

Nevertheless, any rights or claims which may have been in force against such effects before they became part of the property of the association are not invalidated by the foregoing paragraphs.

SEC. 14. As long as the association exists, claims of the association cannot be compensated, either in their whole extent or in part, by the private claims which the person indebted to the association can raise against a member of the association.

SEC. 15. If the private creditor of an associate, after fruitlessly distraining upon the private property of such associate, obtains a right of execution upon the share which would accrue to the associate upon the winding up of the concern, he can, whether the association be founded for a limited or unlimited period, demand for the satisfaction of his debt that the associate leave the association. Notice to that effect must, however, be given at least six months previous to the close of the financial year.

PART III.—OF THE MANAGING BODY, THE COUNCIL OF SUPERVISION, AND THE GENERAL MEETING.

SEC. 16. Every association must have a managing body elected from amongst the associates. By it the association is represented judicially and extra-judicially. The managing body can consist of one or more members, who may be salaried or not. It is at all times removable, with a claim, however, to compensation if such arise out of existing contracts.

SEC. 17. The names of the managing body must immediately on their nomination be notified to the commercial tribunal and be entered on the register, and the tribunal must be made acquainted in an official form with their signature.

SEC. 18. The managing body sign for the association. If the statute contains no particular stipulation on the subject, the signatures of all members of the managing body are required.

SEC. 19. The association obtains rights and is subject to obligations in all legal matters entered into by the managing body on their behalf. It is matter of indifference whether such business has been concluded expressly in the name of the association, or whether circumstances prove that it was the will of the contracting parties that it should be concluded for the association.

The competency of the managing body, in representing the association, extends to those affairs and legal proceedings for which the law requires special full powers. To legitimate the managing body in all matters concerned with the registry of mortgages, a certificate of the commercial tribunal, to the effect that the persons designated are the managing body, suffices.

SEC. 20. The managing body is bound to observe the limits placed to its functions by the statutes or by the resolutions of a general meeting. This limitation of the powers of the managing body, however, is not valid as against other persons.

SEC. 21. Oaths can be taken by the managing body in the name of the association.

SEC. 22. Changes in the members of the managing body must be notified and entered on the register.

SEC. 23. In serving writs on, or giving legal notices to, the association, it suffices that this should be done upon, or to, a member of the managing body who is empowered to sign on behalf of the association.

SEC. 24. The managing body is bound, at the end of each quarter, to notify to the commercial tribunal the names of the members who have joined and of those who have left the association during the quarter, and once a year, in January, to give an exact alphabetical list of all the members.

The tribunal rectifies, by these lists, the original list deposited with it.

SEC. 25. The managing body must, within the first six months of each financial year, publish the balance sheet of the preceding year, and the number of the actual members of the association.

SEC. 26. Members of the managing body who have in that capacity acted beyond the limit of their powers, or against the provisions of the present law, or of the statutes of the association, are liable, with their whole estate, for the losses which may accrue out of such acts.

If they busy themselves with other objects than those specified in the present law, (section 1,) or if they allow, or do not prevent, the discussion of subjects at the general meetings which have no reference to the business of the association, but are concerned with public affairs, (see section 1 of the law of March 11, 1841, for the prevention of the misuse of the right of meeting,) they incur a fine of 200 thalers.

SEC. 27. The statutes can provide for the creation, side by side with the managing body, of a council of supervision. This council superintends the administration of the managing body, in all its branches. It acquaints itself with the state of its affairs, inspects the books and the cash balances, and can convoke general meetings. It can, pending the decision of the general meeting, and if it should seem necessary, depose the managing body, and take the necessary measures for the provisional transaction of the business. It must examine the yearly accounts, and report thereon to the general meeting.

SEC. 28. The council of supervision is charged to bring actions at law against the managing body, if the general meeting has resolved on such action.

If the association has to bring actions against members of the council of supervision, it must, by the vote of a general meeting, name persons, with the necessary full powers, to carry on the suit.

Every member of the association is authorized to intervene in the suit, at his own expense.

SEC. 29. Full powers can be given by the association, *ad hoc*, to other persons than the members of the managing body, or the council of supervision; the exact extent of the functions thus vested in these persons being exactly specified in the full power.

SEC. 30. The general meetings are convoked by the executive body, unless otherwise specified in the statute.

General meetings, besides the occasions for such meetings specified in the statute, are to be convoked whenever it appears in the interest of the association to do so.

SEC. 31. The convoking of the general meeting must take place according to the forms fixed by the statutes.

The subjects for discussion must, on every occasion, be notified simultaneously with the convoking. No resolutions can be passed upon subjects of which notice has not thus been given. For the mere proposing of resolutions, and for discussions not ending with a formal resolution, no such notice is required.

SEC. 32. The managing body is bound to observe and execute all the provisions of the statutes, as well as the resolutions of the general meetings passed conformably to the said statutes.

The resolutions of the general meetings must be entered in a register of protocols, which must be open to the inspection of every associate, and of the organs of the government.

PART IV.—OF THE DISSOLUTION OF THE ASSOCIATION, AND THE LEAVING IT BY INDIVIDUAL ASSOCIATIONS.

SEC. 33. The association is dissolved—

1. By the conclusion of the period for which it was formed;
2. By a resolution of the association;
3. By a declaration of bankruptcy.

SEC. 34. If an association is guilty of illegal acts by which the welfare of the community suffers, or if it pursues other objects than those business objects specified in the present law, (sec. 1,) it can be dissolved without claim to compensation.

In such a case the dissolution can only take place upon the passing of a judicial sentence on the prosecution of the district authorities. The competent tribunal is that to whose ordinary jurisdiction the association is subject.

The sentence of the tribunal is to be communicated to the tribunal which keeps the register of the association, that it may be entered therein and published, according to section 36.

SEC. 35. The dissolution of the association, if it does not take place in consequence of a declaration of bankruptcy, must be notified by the managing body for entry in the register of the association, and must be announced three times consecutively in the public journals.

This announcement must besides call upon the creditors of the association to send in their claims to the managing body.

SEC. 36. The declaration of bankruptcy is to be officially entered in the register by the tribunal charged with the bankruptcy proceedings, and notice of the same is likewise to be published in the public papers.

SEC. 37. Every associate has the right to leave the association. It

there are no express stipulations in the statutes on the subject, the associate can only leave at the close of the financial year, and must give a four weeks' notice at the least. Membership, moreover, ceases with death, unless the statutes contain stipulations carrying such membership on to the heirs at law.

The association can, on grounds which must be specified in the statute, exclude members from the association.

SEC. 38. The associates who leave, or who are excluded from the association, as also the heirs of deceased members, remain liable for all debts of the association contracted before the date of the cessation of membership, until the period of limitation.

Unless the statutes contain stipulations to the contrary, such persons have no claims on the reserved fund, or the corporate property of the association, and can only demand the repayment of their shares with the dividends accrued upon them, such repayment to be made within three months of their leaving the association.

The association can only protect itself against such a claim, even if the property of the association should have diminished at the time of such cessation of membership, by dissolving itself and proceeding to wind up the business.

PART IV.—OF THE WINDING UP OF THE ASSOCIATION.

SEC. 39. After the dissolution of the association, except in the case of bankruptcy, the winding up of its business is undertaken by the managing body, unless the statutes or a resolution of the association designate some other persons for that purpose. The appointment of the liquidators is always revocable.

SEC. 40. The liquidators must be notified to the tribunal of commerce, and their names entered on the register. If a liquidator vacates his office, or if his power of attorney expires, notice must likewise be given.

SEC. 41. The relations of the liquidators towards other persons are determined by sections 25 and 40 of the General German Commercial Code. If there are several liquidators they can only legally transact business by doing so in common, unless it be specially stipulated that they can do so individually.

SEC. 42. The liquidators have to wind up the current business, to fulfil the engagements of the dissolved association, to call in outstanding claims, and to convert the property of the association into cash. They have to represent the association judicially and extra-judicially; they can compound and make compromises. To wind up current business, they can enter into fresh engagements.

The liquidators can only effect the sale of real property by auction, unless there be stipulations to the contrary in the statute or resolutions of the association.

SEC. 43. The limitations of the functions of the liquidators as against other persons has no legal force.

SEC. 44. The liquidators have to give their signature in such a manner that they affix their names to the former name of the association, which is now to be designated as the name of the union to be wound up.

SEC. 45. The liquidators have, in the management of the business committed into their hands, to conform themselves to the resolutions passed by the general meeting.

SEC. 46. The moneys in the hands of the association at the time of dissolution, and those which during the process of winding up flow into the hands of the liquidators, are to be applied as follows:

(*a.*) First, the creditors of the association are to be satisfied as the money owing to them falls due.

(*b.*) From what remains, the shares, with the dividends accrued upon them, are to be repaid to the associates. If the assets are not sufficient to pay these in full, the distribution takes place according to the relative proportions of the shares.

(*c.*) From what remains after paying the debts of the association and the shares of the members, there will, in the first place, be distributed the profits of the last year as prescribed by the statutes. If any property should then remain, the same, in the absence of special stipulations to that effect, shall be distributed amongst the members per head.

SEC. 47. The liquidators must begin by drawing up a balance-sheet. Should the result of this balance-sheet be that the property of the association (inclusive of the reserve fund and the share capital) does not suffice to cover the debts of the association, the liquidators have at once on their own responsibility to call a general meeting, and hereupon, if within eight days the associates have not contributed sufficiently to cover the deficit, they have to apply for the opening of the commercial bankruptcy in regard to the assets of the association.

SEC. 48. Notwithstanding the dissolution of the association the legal status of the associates *inter se*, and towards other persons, remains until the close of the liquidation the same as that laid down in Parts II and III of the present law. In the event of the dissolution of the association, no member can be made liable by means of regress on account of the smaller amount of the calls on shares which he may have paid according to the statutes, by the other members of the association, who have paid up more on their shares. The jurisdiction under which the union was at the time of its dissolution remains in force for the union which is to be dissolved, till the close of the winding up. Citations addressed to the associations can be delivered to the hand of one of the liquidators.

SEC. 49. After the conclusion of the winding up, the books and papers of the late associations are to be given into the custody of one of the former associates, or of a third person. If agreement cannot be come to as to who this person should be, the tribunal of commerce determines.

The associates and their heirs retain the right of examining and using these books.

SEC. 50. Besides the case provided for by section 47, bankruptcy is declared whenever the association, either before or after dissolution, has stopped payment. (See section 281, No. 2, of the bankruptcy law, &c.

The notice of such stoppage of payment, if before the dissolution of the association, must be given by the managing body; if afterwards, by the liquidators.

The association is represented in the one case by the managing body, in the other by the liquidators. Such representatives have to appear personally to give the necessary information, as in the case of an ordinary debtor. A concordate cannot take place.

The declaration of bankruptcy in regard to the corporate property of the association does not involve a declaration of bankruptcy in regard to the private property of the associates.

The decision in regard to the opening of bankruptcy must not contain the names of the members who are jointly and severally liable.

As soon as the bankruptcy proceedings are ended the creditors have the right to recover their claims (only in so far, however, as they were put in and verified during the bankruptcy proceedings, but inclusive of interests and costs) on the private property of the individual associates.

PART VI.—OF THE LIMITATION OF CLAIMS AGAINST ASSOCIATES.

SEC. 51. The limitation of claims against an associate for debts incurred by the association during membership comes into force two years after the dissolution of the association, or after the date of his quitting the association or being excluded from it, in so far as the peculiar character of the claim does not involve a shorter period.

The two years are reckoned from the day on which the dissolution of the association was entered on the register, or the cessation of membership was notified to the tribunal of commerce. If the claim became only due after this date, the time is reckoned from the date at which such claim became due. If there remain undistributed assets, the two years' limitation cannot be enforced against the creditor in so far as he founds his claim only on the corporate property of the association.

SEC. 52. The limitation in favor of a member who has quitted it or been excluded is not interrupted by legal proceedings undertaken against another member of the association, but by legal proceedings undertaken against the still existing association.

The limitation in favor of a member of the association who belonged to it at the time of dissolution is not interrupted by legal proceedings undertaken against the liquidators or the bankruptcy.

SEC. 53. The limitation runs likewise against minors and persons under guardianship, as well as against corporations which legally enjoy the rights of minors, without admittance of the *restitutio in integrum*, but with the proviso of redress against the guardians and administrators.

CONCLUDING PROVISIONS.

SEC. 54. The commercial tribunal holds the managing body to the observance of sections 4, 16, 17, 22, 24, 25, 32, 35, 40, by the infliction of fines and penalties, as provided in section 5 of the introductory portion of the General German Commercial Code of 24th June, 1861.

Inaccuracies in the notices given by the managing body are to be fined 20 thalers.

SEC. 55. Section 55 does not exclude more rigorous measures, if they are enjoined by other laws.

SEC. 56. The registrations take place free of cost. The details respecting the way in which the registers shall be kept will be given in a general instruction, to be drawn up by the ministers for commerce, industry, and public works, and justice.

The ministers aforesaid are charged with the enforcement of the present law.

FRENCH LAW OF COMPANIES.

[Extract from the French law of "Companies," of 24th to 29th January, A. D. 1867.]

TITLE III.—PARTICULAR PROVISIONS FOR SOCIETIES WITH VARIABLE CAPITAL.

ART. 48. It may be stipulated in the by-laws of any society that the capital of the society will be susceptible of augmentation by successive payments made by the members or the admission of new members, and of diminution by the withdrawal, total or partial, of the payments already made.

The societies whose by-laws shall contain the above stipulation will be subject, independently of the general rules which apply to them according to their particular form, to the provisions of the following articles:

ART. 49. The capital of the society may not be fixed by the constituting laws of the society above the sum of 200,000 francs. It may be augmented by the deliberations of the general assembly held from year to year. Each augmentation may not exceed 200,000 francs.

ART. 50. The shares or coupons of shares will bear the name of an individual. Even after their entire liberation they may not be less than 50 francs. They will only be negotiable after the definite constitution of the society. The negotiation can only take place by transfer on the register of the society; and the by-laws may give either to the executive council or to the general assembly the right to oppose the transfer.

ART. 51. The by-laws will determine a sum below which the capital may not be reduced by the withdrawals authorized by article 48. The sum shall not be less than one-tenth the capital of the society. The society will be definitely constituted only after the payment of the tenth.

ART. 52. Each member shall be able to retire from the society whenever he may think proper, except by contrary agreement, and except as provided by the first paragraph of the preceding article. It may be stipulated that the general assembly shall have the right to decide, by the majority necessary for the modification of the by-laws, that one or more members shall cease to form part of the society.

Members who cease to form part of the society, either by their will or by the decision of the general assembly, will remain bound to the society and to third parties, during five years, for all the obligations existing at the time of their withdrawal.

ART. 53. The society, whatever may be its form, shall appear in court by its officers.

ART. 54. The society will not be dissolved by the death, withdrawal, suspension, failure, or bankruptcy of one of the members; it will continue in full force between the other members.

UNITED KINGDOM.

ANNO VICESIMO QUINTO & VICESIMO SEXTO VICTORIÆ REGINÆ.

CAP. LXXXVII.—An act to consolidate and amend the laws relating to industrial and provident societies.—7th August, 1862.

Whereas by the industrial and provident societies act, 1852, it is enacted, that it shall be lawful for any number of persons to establish a society under the provisions thereof and of the therein-recited act, for the purpose of raising by voluntary subscriptions of the members thereof a fund for attaining any purpose or object for the time being authorized by the laws in force with respect to friendly societies or by the said recited act, by carrying on or exercising in common any labor, trade, or handicraft, or several labors, trades, or handicrafts, except the working of mines, minerals, or quarries beyond the limits of the United Kingdom of Great Britain and Ireland, and also except the business of banking, whether in the said United Kingdom or elsewhere, and that the said act shall apply to all societies already established for any of the purposes herein mentioned, so soon as they shall conform to the provisions hereof; and whereas, by an act passed in the seventeenth and eighteenth years of her present Majesty, chapter twenty-five, various provisions were made for the better enabling legal proceedings to be carried on in any matter concerning the societies formed under the said act of 1852; and whereas the last-mentioned act was amended by an act passed in the first session of the nineteenth and twentieth years of her present Majesty, chapter forty; and whereas various societies have been formed and are now carrying on business under the provisions of the said recited acts, and it is desirable to consolidate and amend the laws relating to such societies: Be it therefore enacted by the Queen's most excellent Majesty, by and with the advice and consent of the Lords spiritual and temporal,

and Commons, in this present Parliament assembled, and by the authority of the same, as follows:

1. The industrial and provident societies act, 1852, and the said recited acts for the amendment thereof, are hereby repealed from the passing of this act.

2. All societies registered under the industrial and provident societies act, 1852, shall be entitled to obtain a certificate of registration on application to the registrar of friendly societies, and for which certificate no fee shall be payable to the registrar.

3. Any number of persons, not being less than seven, may establish a society under this act for the purpose of carrying on any labor, trade, or handicraft, whether wholesale or retail, except the working of mines or quarries, and except the business of banking, and of applying the profits for any purposes allowed by the friendly societies acts, or otherwise permitted by law.

4. The rules of every such society shall contain provisions in respect of the several matters mentioned in the schedule annexed to this act.

5. Two copies of the rules shall be forwarded to the registrar of friendly societies in England, Scotland, or Ireland, according to the place where the office of the society is situate, and shall be dealt with by him in the manner provided by the friendly societies act, 1855; and he shall thereupon give his certificate of registration, and such certificate shall in all cases be conclusive evidence that the society has been duly registered, and thereupon the members of such society shall become a body corporate, by the name therein described, having a perpetual succession and a common seal, with power to hold lands and buildings, with limited liability.

6. The certificate of registration shall vest in the society all the property that may at the time be vested in any person in trust for the society; and all legal proceedings then pending by or against any such trustee or other officer on account of the society may be prosecuted by or against the society in its registered name without abatement.

7. A copy of the rules shall be delivered by the society to every person, on demand, on payment of the sum not exceeding one shilling.

8. No society shall be registered under a name identical with that by which any other existing society has been registered, or so nearly resembling such name as to be likely to deceive the members or the public, and the word "limited" shall be the last word in the name of every society registered under this act.

9. No member shall be entitled, in a society registered under this act, to hold or claim any interest exceeding the sum of two hundred pounds.

10. Every society registered under this act shall paint or affix, and shall keep painted or affixed, its name on the outside of every office or place in which the business of the society is carried on, in conspicuous position, in letters easily legible, and shall have its name engraven in legible characters on its seal, and shall have its name mentioned in legi-

ble characters in all notices, advertisements, and other official publications of such society, and in all bills of exchange, promissory notes, indorsements, checks, and orders for money or goods purporting to be signed by or on behalf of such company, and in all bills of parcels, invoices, receipts, and letters of credit of the society.

11. If any society under this act does not paint or affix, and keep painted or affixed, its name in manner directed by this act, it shall be liable to a penalty not exceeding five pounds for not so painting or affixing its name, and for every day during which such name is not so kept painted or affixed; and if any officer of such society or any person on its behalf uses any seal purporting to be a seal of the society whereon its name is not so engraven as aforesaid, or issues or authorizes the issue of any notice, advertisement, or other official publication of such society, or signs or authorizes to be signed on behalf of such society any bill of exchange, promissory note, indorsement, check, order for money or goods, or issues or authorizes to be issued any bill of parcels, invoice, receipt, or letter of credit of the society, wherein its name is not mentioned in manner aforesaid, he shall be liable to a penalty of fifty pounds, and shall further be personally liable to the holder of any such bill of exchange, promissory note, check, or order for money or goods, for the amount thereof, unless the same is duly paid by the society.

12. Every society under this act shall have a registered office to which all communications and notices may be addressed. If any society registered under this act carries on business without having such an office, it shall incur a penalty not exceeding five pounds for every day during which business is so carried on.

13. Notice of the situation of such registered office, and of any change therein, shall be given to the registrar, and recorded by him: until such notice is given, the society shall not be deemed to have complied with the provisions of this act.

14. The rules of every society registered under this act shall bind the society, and the members thereof, to the same extent as if each member had subscribed his name and affixed his seal thereto, and there were in such rules contained a covenant on the part of himself, his heirs, executors, and administrators, to conform to such rules subject to the provisions of this act; and all moneys payable by any member of this society in pursuance of such rules shall be deemed to be a debt due from such member of the society.

15. The provisions of the friendly societies acts shall apply to societies registered under this act in the following particulars:

Exemption from stamp duties and income tax;

Settlements of disputes by arbitration or justices;

Compensation to members unjustly excluded;

Powers of justices or county courts in case of fraud;

Jurisdiction of the registrar.

16. The provisions of the friendly societies act, 1854, whereby a mem-

ber of any society registered thereunder is allowed to nominate any person to whom his investment to such society shall be paid, shall extend, in the case of societies registered under this act, to allow any member thereof to nominate any person into whose name his interest in such society at his decease shall be transferred; provided, nevertheless, that any such society may, in lieu of making such transfer, elect to pay to any person so nominated the full value of such interest.

17. Any society registered under this act may be wound up either by the court or voluntarily, in the same manner and under the same circumstances under and in which any company may be wound up under any acts or act for the time being in force for winding up companies; and all the provisions of such acts or act with respect to winding up shall apply to such society, with this exception, that the court having jurisdiction in the winding up shall be the county court of the district in which the office of the society is situated.

18. In case of the dissolution of any such society, such society shall nevertheless be considered as subsisting, and be in all respects subject to the provisions of this act, so long and so far as any matters relating to the same remain unsettled, to the intent that such society may do all things necessary to the winding up of the concerns thereof, and that it may be sued and sue under the provisions of this act, in respect of all matters relating to such society.

19. The provisions of the joint-stock companies acts as to bills of exchange and the admissibility of the register of shares in evidence shall apply to all societies registered under this act.

20. In the event of a society registered under this act being wound up, every present and past member of such society shall be liable to contribute to the assets of the society to an amount sufficient for payment of the debts and liabilities of the society, and the costs, charges, and expenses of the winding up, and for the payment of such sums as may be required for the adjustment of the rights of the contributories among themselves, with the qualifications following—that is to say:

1. No past member shall be liable to contribute to the assets of the society if he has ceased to be a member for a period of one year or upwards prior to the commencement of the winding up.

2. No past member shall be liable to contribute in respect of any debt or liability of the society contracted after the time at which he ceased to be a member.

3. No past member shall be liable to contribute to the assets of the society unless it appears to the court that the existing members are unable to satisfy the contributions required to be made by them in order to satisfy all just demands upon such society.

4. No contribution shall be required from any member exceeding the amount (if any) unpaid on the shares in respect of which he is liable as a past or present member.

21. Any society registered under this act may be constituted a company

under the companies acts, by conforming to the provisions set forth in such act, and thereupon shall cease to retain its registration under this act.

22. Every person or member having an interest in the funds of any society registered under this act may inspect the books and the names of the members at all reasonable hours at the office of the society.

23. The sheriff in Scotland shall, within his county, have the like jurisdiction as is hereby given to the judge of the county court in any matter arising under this act.

24. A general statement of the funds and effects of any society registered under this act shall be transmitted to the registrar once in every year, and shall exhibit fully the assets and liabilities of the society, and shall be prepared and made out within such period, and in such form, and shall comprise such particulars as the registrar shall from time to time require; and the registrar shall have authority to require such evidence as he may think expedient of all matters required to be done, and of all documents required to be transmitted to him under this act; and every member of or any depositor in any such society shall be entitled to receive, on application to the treasurer or secretary of that society, a copy of such statement, without making any payment for the same.

25. All penalties imposed by this act, or by the rules of any society registered under this act, may be recovered in a summary manner before two justices, as directed by an act passed in the eleventh and twelfth years of the reign of her present Majesty Queen Victoria, chapter forty-three, entitled, "An act to facilitate the performance of the duties of justices of the peace out of sessions within England and Wales, with respect to summary convictions and orders."

26. This act may be cited as "The industrial and provident societies act, 1862."

SCHEDULE OF MATTERS TO BE PROVIDED FOR IN THE RULES.

1. Object and name and place of office of the society, which must, in all cases, be registered as one of limited liability.
2. Terms of admission of members.
3. Mode of holding meetings and right of voting, and of making or altering rules.
4. Determination whether the shares shall be transferable; and in case it be determined that the shares shall be transferable, provision for the form of transfer and registration of shares and for the consent of the committee of management and confirmation by the general meeting of the society; and in case shares shall not be transferable, provision for paying to members balance due to them on withdrawing from the society.
5. Provision for the audit of accounts.
6. Power to invest part of capital in another society; provided that no such investment be made in any other society not registered under this act, or the joint stock companies act, as a society or company with limited liability.

7. Power and mode of withdrawing from the society, and provisions for the claims of executors, administrators, or assigns of members.

8. Mode of application of profits.

9. Appointment of managers and other officers, and their respective powers and remuneration.

PROVISION AUTHORIZING INDUSTRIAL PARTNERSHIPS.

Extract from the "act to amend the law of partnership," 28 and 29 Victoria, chap. 86, (July 5, 1865:)

"No contract for the remuneration of a servant or agent of any person engaged in any trade, or undertaking by a share of the profits of such trade or undertaking, shall, of itself, render such servant or agent responsible as a partner therein, nor give him the rights of a partner."

APPENDIX F.

THE MANUFACTURE AND WEAR OF RAILS.

By Christer Peter Sandberg, *Associate of the Institute of Civil Engineers.*

A paper (No. 1,196,) *read before the Royal Society of Civil Engineers in London, March* 3, 1868, *by C. P. Sandberg, esq.; Charles Hutton Gregory, president, in the chair.*

In these times, when communication between different places is carried on mainly by the system of railways, it becomes important to determine the best mode of manufacturing railway bars, so as to obtain the greatest amount of wear at the least possible cost. As this question is one of increasing interest, the author has thought it might be profitable to communicate to the members of the Institution of Civil Engineers the experience he has gained during the last six or seven years, while engaged in superintending the supply of rails to the three Scandinavian countries, Sweden, Norway, and Denmark.

The paper will be divided into three parts. First, as to the best method of manufacturing rails out of common iron, and as to the time they will last. Secondly, as to the disposal of the iron rails when they are worn out; and thirdly, as to whether iron or steel, or a combination of the two materials, is the most economical to use for rails.

BEST METHOD OF MANUFACTURING RAILS FROM COMMON IRON.

The mode of manufacturing rails for Sweden, as carried out in Wales between the years 1856 to 1860, consisted in hammering the pile for the top slab after the first welding heat, and in rolling it after the second heat. It was supposed that hammering would produce a superior weld and a harder wearing surface than could be obtained by rolling alone. This method was, however, gradually superseded at other works in England and in Wales, during the period referred to, by rolling only. Hammering the slab, after the first welding heat, entailed an additional charge of 20*s.* per ton; it therefore became the duty of the Swedish government to determine, by practical trials, whether the value of the finished rail was correspondingly increased. With this object in view, several rails were rolled, and arrangements were made for putting them down in such situations, on some of the English lines, as would expose them to severe wear. The experiments further aimed at discovering, if possible, how long the rails manufactured at the Cwm Avon Works, in South Wales, and imported into Sweden, would resist the traffic in that country. Five different kinds of "piles" were employed; twenty rails, of a flange section, 4½ inches deep, and weighing 62 pounds per yard, being rolled of each particular sort. The mode of manufacture was as follows:

The rails marked T were made from a pile formed of No. 2, or welded iron, for the top and bottom, the rest of the pile being of No. 1 puddled bar iron. The top slab and the squares next to it were made from a hammered bloom of ordinary puddled iron, and filled in at the middle with crop ends from top slabs, and other pieces of No. 2 iron.

The rails marked Y were made from a pile of the same composition as that of the T rails, with the difference that the pile for the top slab consisted of puddled bars, without any welded iron pieces or crop ends being introduced in the middle of the pile.

The pile for the rails marked H was composed of a top slab made from puddled bars, hammered after the first heat, and rolled after the second heat, similar to the rails marked Y, the iron for the flange consisting of four pieces instead of eight.

The pile for the rails marked E was exactly similar to that for the rails marked H, excepting that the pile for the top slabs was rolled after the first heat, as well as after the second heat. This difference in the mode of manufacture was adopted in order to discover whether, in this common iron, hammering improved the rail to a corresponding extent. Instead of No. 2 iron, puddled bars were chiefly used for the squares near the slab, and for the foot of the rail.

The pile for the rails marked N consisted of puddled bars without any top slab. All the piles passed through the rolling successfully with the exception of the N rails, some of which showed cracks, owing to the inferior quality of the puddled bar.

The London and Northwestern Railway Company, being interested in the solution of this problem, allowed experiments to be made on their line, so far as the wear of these experimental rails was concerned. The experiments were carried out at Camden Town Station, where the rails could be better and more thoroughly tried than elsewhere. First, on account of the enormous traffic which obtains at that spot; secondly, from the constant shunting, and, thirdly, owing to the grinding action of the engine wheels in starting the trains. The result of these experiments is shown in a series of tables, drawn up by Mr. H. Woodhouse, superintendent of permanent way. (See Appendix.)

The following table shows the number of tons passed over each experimental rail before it was crushed, and also before the rails were taken out:

Mark of rail.	Crushed.	Worn out.
	Tons.	*Tons.*
T	3,680,000	5,061,000
Y	4,140,000	5,290,000
H	3,220,000	5,060,000
E	6,900,000	8,970,000
N	3,280,000	5,320,000

Another table, calculated from the preceding one, shows how long the *rails will last*, supposing them to be passed over by 3,000 trains yearly

each train being composed of an engine weighing 30 tons, and of 20 wagons of 10 tons each, or a gross load of 230 tons.

From these tables it was ascertained that the five different descriptions of rails were on the average crushed in six years, and worn out in nine years, thus:

T.		Y.		H.		E.		N.	
Crushed.	Worn out.	Crushed.	Worn out.	Crushed.	Worn out.	Crushed.	Worn out.	Crushed.	Worn out.
Years. 5	*Years.* 7	*Years.* 6	*Years.* 7	*Years.* 5	*Years.* 7	*Years.* 10	*Years.* 13	*Years.* 5	*Years.* 8

As the object of these experiments was chiefly to ascertain the difference between a rolled and a hammered slab, both made from inferior iron, E representing the former and H the latter, those rails were placed so as to compare their relative resistance to wear; and the result shows the E rail with the rolled slab to be superior at each place where the rails were tested.

Among the other descriptions of rails the N section endured the longest, although it had no top slab of No. 2 iron.

The conclusion is thus arrived at that hammering after the first welding heat, for this particular kind of iron, does not improve the endurance of the rails, but that the simplest mode of manufacture has also the material advantage of being the best. These trials at the same time establish the fact that it is not the wear or the diminished sectional area caused by abrasion which produces the unsatisfactory results in the endurance of iron rails, but the lamination caused by imperfect welding. This explains the great difference in the result between the wear of rails made in exactly the same way, the welding in the one case being perfect, whilst in the other it has been very imperfect.

The results obtained at the Camden Town station, however, are not applicable to the circumstances and conditions of the wear of rails which occurs under ordinary traffic, but rather to exceptional situations, where the wear is occasioned principally by the frequent use of the brakes and by continual shunting, in a much higher degree than at any other point of the line. These results may also be attributed, in part, to the great weight of the locomotives in proportion to the weight of this particular section of rail.

Rails of the same dimensions and of similar quality of iron to those marked E have been tried on the Great Northern railway, and have lasted during the passage of about 65,000 trains of a total aggregate weight of 13,000,000 tons, one-fourth part of this traffic being at a speed of about 40 English miles per hour, and the remaining three-fourths of 15 miles an hour.

These experiments confirm the rule laid down in Mr. R. Price Williams's paper "On the Maintenance of Permanent Way," viz., that

the endurance of rails may be measured by the product of the speed and of the passing weight. The trial rails on the Great Northern railway may thus be said to have borne 276,000,000 tons at a speed of one mile per hour. The endurance of the rails tried at Camden Town, under such unusual conditions, is much less, and may be represented by 120,000,000 tons at a speed of one mile per hour.

Another method of arriving at a judgment as to the endurance of these rails on the Swedish state lines, is found in the renewals which have been already made on those railways. The present experience extends over a period of nine years on portions of the most severely worked lines, namely, at Gottenburg and Malmo, and also during a period of six years on the whole system. The renewals on the main line have been in an increasing proportion, being in one case 30 or 40 per cent. higher than in the preceding year; and a mean calculation gives the probable result that, taking the last renewals of the rails laid down on the construction of the lines at about 18 years from the commencement, the average life of the rails will be 15 years.

The weight which has passed over the rails during these 15 years, judging from the reports contained in the annual accounts of the government railway administration as to the traffic returns of all the state lines during the years 1862 to 1865, may be assumed to be a yearly increase, in the gross load, of only 15 per cent. per mile after the year 1865. The yearly increase, however, on the line nearest Gottenburg since 1862, of transported goods, has amounted to 30 per cent., and near Malmo to 18 per cent. Further, supposing the same proportion to exist between the gross and the net loads for the year 1865, it may be taken at about 6,000,000 tons, a quantity which compares with the results obtained on the English lines, giving for the life of the best of the three first sort of rails the same average life as that of the E rails. This confirms the correctness of the theory that the life of rails is measured by the product of the weight and the speed.

The rails used on the Swedish lines are mostly of the E or rolled class before mentioned. Those tried on the Great Northern line were also of that kind of manufacture, but of a heavier section. The speed at which the load was carried over the experimental rails on the Great Northern railway was much higher than on the Swedish lines, being in the proportion of 20 on the Great Northern to 16 miles average speed on the Swedish railways.

The conclusions the author has arrived at are, that no rule can be laid down for the manufacture of rails that will apply to every manufacturing district; but that in the case of Welsh iron, to which he has more particularly referred, it has been proved that the best method of manufacturing the rail is that now most commonly practiced, viz: rolling the iron into bars, piling these, and repeated rolling to the finished rail without hammering. The author assumes the prejudicial result from *hammering* to be owing to the large amount of sulphur in the Welsh

iron. Where the iron contains more phosphorus and less sulphur, as, for instance, in the Cleveland, Belgian, and French iron districts, hammering has proved beneficial, and rails have been made direct from puddled bars without the intermediate process of piling, this being, in fact, the method generally adopted in those places, and being found to answer best.

These experiments seem to indicate that 220,000,000 tons may be carried over rails, of the section and make referred to, at a speed of one mile per hour; so that any railway company, knowing the load which yearly passes over their line and the speed, may, by multiplying the one into the other, and dividing this product by 220, ascertain the life of iron rails in years.

DISPOSAL OF IRON RAILS WHEN WORN OUT.

As to the disposal of the rails when worn out, and as to the possibility of rerolling old rails with advantage by companies far situated from the seat of manufacture, such as the British colonies, the countries around the Mediterranean or the Baltic, the author thinks that for railways near the seat of rail manufacture, the best way will be to continue to sell the old rails to the rail mills. For other countries, situated like Sweden for instance, it becomes important to ascertain whether it would not be more advantageous to reroll them.

The increasing traffic, the augmented speed, together with the heavier engines now found desirable, have all a tendency to more severe wear, and to render necessary more frequent renewals of the rails. These renewals are executed with more and more difficulty, as the greater number of trains limits the time at disposal, whilst the stoppage of the traffic thus occasioned often results in accidents. These considerations, together with the recurring expenses of renewals, have conduced to the employment of a more durable material for rails, as steel, which is already much used. The new rails have been manufactured either entirely of steel, or iron rails have had steel tops added to them.

In the case of steel-top rails the head has either been entirely formed of steel, or else the upper surface only has been covered with a thinner or thicker top slab, say half an inch thick in the rail. The top slab has been joined according to the different methods used for forming the pile, so that it has been either lying flat over the wearing part of the rail head, or it has spanned the mass of iron with its exterior edges, thus fixing the steel without reference to the weld; it has, in fact, been partly mechanically fastened to it. The mode of making the pile at several places where old rails have been used instead of puddled bars, is shown in the plans, Figs. A, B, and C.[1] The pile used at Dowlais for 120 tons of steel-headed rails for the Swedish government railways in September last is shown in Plan B, and the one used at Hörde, in Germany, Plan A, all for the manufacture of steel-headed rails.

[1] These illustrations are omitted.

The use of steel rails has much increased in England, and many railway companies are adopting them as fast as their financial circumstances will allow.

The existence of a cheap raw material in the shape of old rails, and rerolling them together with Bessemer steel tops, affords an opening for carrying out the manufacture of rails profitably for railway companies far removed from the seat of manufacture, even when exposed to foreign competition. If such rerolling were carried out in Sweden, instead of selling the worn out iron rails in England, the expense of freight to and fro would be saved, which may be reckoned at £2 per ton. The necessary cost of coal would not increase the price of rails more than about 10*s*. per ton for rerolling rails in Sweden.

The question is thus reduced to an inquiry whether the increased cost of manufacture, due to the smallness of the quantity to be made, would amount to, or exceed, the remaining part of the difference of the freight, £1 10*s*. per ton. If so, it would then be of no use to attempt the establishment of a manufacture of rails, either by the government in connection with other workshops for the repair and renewal of railway materials of other kinds, such as engines, axles, wheels, etc., or by private capitalists.

An estimate has been made, the particulars of which will be found in the appendix, of the cost of manufacturing rails in Sweden, composed of Swedish Bessemer steel for the head, No. 2 iron for the flange or foot, the remainder of the pile being of old iron rails. The rails are of the Vignoles section, weighing 66 pounds per yard.

From these calculations it is shown:

1. That according to plan A, with the whole head of Bessemer steel, the cost per ton on an annual make of 10,000 tons is £8 12*s*. 1*d*.; and secondly, according to plan B, with the top or wearing surface of the rail only of Bessemer steel, the cost per ton on an annual make of 6,000 tons is £8 6*s*. 8*d*.

It therefore follows that the difference between these amounts and £10, the lowest price at which such rails can be imported into Sweden from England, viz. £1 7*s*. 11*d*., by plan A, and £1 13*s*. 4*d*., by plan B, respectively represents the net profit to be derived from the transfer of rerolling operations to Sweden. In other words, providing this calculation is not too low, this represents in the first case 16 per cent., and in the second case about 20 per cent. of the whole cost of production.

In England, the London and North Western, and the Great Western railway companies are rerolling the worn-out rails at their own workshops, where the repairs of other railway materials are also executed, and at both these places Bessemer steel has been used for the head of the rails. The other English railway companies are selling their worn-out rails, as there is sufficient competition to prevent them being sold below the market price.

There is no railway company in France which has works for rerolling the

worn-out rails; neither is there any in Belgium or in Prussia, the rails being sold to the private rail mills in the respective countries, and being used in connection with other iron for rail manufacture.

In Austria, the state railways are carrying out the rerolling of rails at the state's own workshops at Grätz, while the making of axles and tires is performed at the state's workshop at Neuberg.

In Russia, the rolling of the rails is executed at a workshop near St. Petersburg, altered for the purpose by a private company. The side irons and top slabs are of manufacture, but sometimes the top slabs are made at home from scrap iron. The English fuel is used. The Petersburg and Moscow railway receive in exchange for their old rails three-quarters of their weight in new rails, and pay a certain sum, according to the specification, for each weight of rails received. By the other great Russian railway the old rails were at first sent to England, but for some time a private iron-work near Petersburg, called Orgareff, has carried on the rerolling on the following conditions: The railway company finds one ton of old rails, and receives one ton of new rails, and pays £7 14*s.* per ton, but has then a guarantee for five years.

Having stated the case of Sweden as an example, other railways in similar circumstances in the British colonies and in the countries round the Mediterranean may be similarly dealt with. The special conditions being different in each case, make it difficult, if not impossible, to give an example that would suit every case. The principle laid down may be useful as a guide as to what is to be done with the rails when worn out.

THE MOST ECONOMICAL MATERIAL TO BE EMPLOYED FOR RAILS.

In the first part of the third division of the paper, as to the best and most economical material to be employed for rails, the particular circumstances affecting Sweden are considered.

From these facts the following conclusions are drawn:

First. That solid Bessemer steel rails, which are not likely to be manufactured at a cheaper price in Sweden than in England, or £13 per ton, are too dear to use on the Swedish railways.

Second. That the Swedish puddled steel rails, which cannot be manufactured for less than £12 per ton, are also too dear for the railways, even if they should last twice as long as iron rails of English make.

Third. That steel top rails at £10 per ton are the cheapest for the Swedish railways, being cheaper than rails of Welsh iron at £8 per ton; and that it will thus become the duty of the railways administration to procure such a steel-top rail, not only for the new lines about to be constructed, but also for the maintenance of the existing lines.

In arriving at these conclusions, it must be admitted that, up to the present time, the experience of the durability of the different kinds of rails has not been sufficient to render the conclusions drawn thoroughly reliable.

Further, this experience of the durability of the steel-top rail and of the solid steel rail may not agree with individual cases of failure where, in consequence of defective welding, the steel head has come off, or where the solid steel rail has broken. At the same time, it must be admitted that the process of steel making, and of welding the steel slats to the rail, is, as yet, in its infancy, so that great progress may yet be expected. The principle ought not to be condemned because of individual failures.

Assuming that, under a very heavy traffic, common iron rails last five years, steel-top rails 15 years, and solid steel rails 30 years, and that the iron rails cost £7 per ton, steel-top rails £10 per ton, and solid steel rails £15 per ton, and that the old steel-top and iron rails are valued at £4 per ton, and the old solid steel at £8 per ton, then with a rail section of 84 pounds per yard, 250 tons of rails will be required for one mile of double line, and the cost of laying the rails may be estimated at £1 per ton. The following example, as to iron rails lasting five years, will serve to explain the way in which the subsequent annuity tables have been calculated:

Two hundred and fifty tons, at £7 per ton	£1,750
Cost of laying down	250
Total	2,000
Which sum, at the end of five years, at five per cent. compound interest, becomes	2,552
The difference between this sum (£2,552) and the value of the old rails (250 tons at £4 per ton=£1,000) is	1,552

The annuity required to recoup this latter sum in five years is £280.

For one English mile of double line, interest being reckoned at 5 per cent., and steel-top rails being calculated to last three times and solid steel rails six times as long as iron rails:

Annuity table.—No. 1.

When iron rails last—	The annuity would be for—		
	Iron rails.	Steel-top rails.	Solid steel rails.
2 years	£587	£395	£335
3 ..do	417	307	271
4 ..do	332	247	245
5 ..do	280	218	230
10..do	179	163	205
15..do	134	148	201
20..do	130	140	200

It may be objected that the prices quoted for solid steel rails in the foregoing calculations are too high. Rails of this kind have been sold in some places as low as £12 per ton, but for the very best quality the present price is £15 per ton, and it is only from these that the experience has been gained as to their enduring six times as long as iron rails. However, table No. 2 has been calculated for the different kinds and periods at the following prices, viz: iron rails at £6, steel-top rails at £9, and solid steel rails at £12 per ton, crediting the old iron and steel-top rails at £3 per ton, and the solid steel rails at £5 per ton.

Annuity table.—No. 2.

When iron rails last—	The annuity would be for—		
	Iron rails.	Steel-top rails.	Solid steel rails.
2 years	£574	£382	£288
3 ..do	404	283	233
4 ..do	319	234	230
5 ..do	268	206	174
10..do	166	149	168
15..do	133	136	163
20..do	117	126	150

This table shows that in all cases, except the last, solid steel rails are the cheapest.

The amount of traffic must, therefore, decide which material it is the most economical to use for the maintenance of the permanent way. For all railways where ordinary iron rails are worn out in five years, or in a shorter time, solid steel rails are the most economical at the price quoted in table No. 1.

When ordinary iron rails last over five and up to ten years, steel-top rails would be the cheapest; iron rails in these cases being clearly proved to be the most expensive, although the cheapest where they last from 15 to 20 years.

As these calculations are founded on the short experience gained up to the present time in reference to the relative endurance of the different kinds of rails, a still longer trial is desirable.

The foregoing tables refer to rails of the Vignoles section. Table No. 3 has been made up for the ordinary double-headed rails, according to the prices stated, the considerations being the same as in table No. 2, except that the chairs have been taken into account. Allowance has been made for 140 tons of new chairs per mile, at £5 per ton, credit being given for the value of the old chairs at £2 10*s*. per ton. It may be observed that steel-headed rails are here estimated to last four times,

and solid steel rails eight times as long as ordinary iron rails; that is, making allowance for the use of both faces:

Annuity table.—No. 3.

When iron rails last—	The annuity would be for—		
	Iron rails.	Steel-top rails.	Solid steel rails.
2 years	£780	£379	£296
3 ..do	551	291	249
4 ..do	436	244	228
5 ..do	366	233	217
10..do	229	177	190
15..do	183	166	....
20..do	163	162	....

This table indicates that the iron rails are in no instance the cheapest; but, on the contrary, that when iron rails last only up to five years, solid steel have the advantage; and where the iron rails have a longer duration, then steel-headed rails are the most economical.

It is to be hoped that railway companies having a heavy traffic will give different sorts of rails great attent on, and submit them to trials on a large scale; and, on the other hand, that the steel works will try their utmost to manufacture solid steel, as well as steel-headed, rails of the best sort for the purpose, so that this important question may soon be decided.

Before concluding, another fact must be taken into consideration, viz., the safety of the three different materials, in regard to high speeds, severe climate, &c. This seems of late to have engaged the attention of the railway world, and has been discussed, not only in England but on the continent. The Swedish government, having undertaken the construction of railways in that country, appointed a committee, composed of many eminent men, to consider it. This committee found it necessary to make experiments with different materials, from England as well as Sweden, and, after five years' consideration and study, the report has just been published by Professor Styffe, the director of the Government School of Mines at Stockholm.

From this report it appears that the tenacity and elongation of different materials are influenced by the amount of carbon.

The tenacity influenced by carbon.

Description of materials.	Carbon per. cent.	Elongation per. cent.
Swedish Bessemer steel and Uchartius steel	1. 85 to 1. 0	0. 3 to 0. 9
For cast steel	0. 69 to 0. 61	1. 2 to 2. 1
Bessemer steel or iron	0. 42 to 0. 33	1. 9 to 4
	Specific gravity.	
Iron from lake ores, (rich in phosphorus)	....	0. 8 to 3. 4
Iron from Dudley, (rich in slag and phosphorus)	7. 5	2. 5 to 4. 2
Iron from Midlesboro'-on-Tees	7. 65	3. 4 to 5. 9
Puddled iron from Sweden and Low Moor	7. 77 to 7. 80	6. 1 to 9. 5
Swedish iron made in refining furnace	7. 84	7. 3 to 7. 8

The absolute strength influenced by carbon.

Description.	Carbon per cent.	Weight in lbs. per sq. inch when broken.
Swedish charcoal puddled iron	0. 8	113, 381
Swedish charcoal puddled iron	0. 7	84, 265
Swedish Bessemer steel	0. 8	90, 921
Swedish Bessemer steel	0. 55	86, 941
Swedish Bessemer steel	0. 50	71, 090
Swedish Bessemer iron	0. 20	48, 102
Swedish puddled iron	0. 70	83, 441
Swedish puddled iron	0. 70	83, 716
Swedish iron from another work	0. 6	73, 492
Swedish iron from another work	0. 6	82, 344
Swedish iron from another work	0. 5	78, 432
Swedish iron from another work	0. 7	86, 049

These tables show that the hardest material has the greatest absolute strength, both before and after permanent set has taken place, but it has the least ductility; on the other hand, a softer material shows the greatest tenacity or elongation, the Bessemer material giving the same results as that prepared from the same pig iron by puddling, refining or the cast-steel process.

In the diagram illustrating these results, the percentage of carbon and phosphorus is stated in nearly all cases. The limit for the amount of carbon seems to be for the Bessemer material 1.2 to 1.5 per centum. With a larger amount the absolute strength, as well as the tenacity, has been found to decrease. When the amount of carbon does not exceed 0.4 per centum, and the material is not worked at too low a heat, the elongation seems to be 16 per centum, or the same as for puddled iron from the same pig iron; and as such Bessemer material is not only much stronger, but also more solid or homogeneous than the puddled material,

it deserves a decided preference for all railway purposes. The few cases of failures of rails by breaking may be accounted for as the result of too hard a material, not perfectly manufactured, having been made at the earlier period of the introduction of the process. The experience which has now been gained should certainly prevent any recurrence of this.

Iron and steel when tried for tensile strength under the influence of extreme temperatures, such as boiling water and at the freezing point of mercury, has led to the discovery, contrary to the general belief, that the tensile and absolute strength is greater during cold than during ordinary temperature; that is, iron or steel is stronger in winter than in summer. The reason why more breakages occur in winter than in summer is asserted to be due to the extreme cold affecting the elasticity of the supports, (sleepers,) and that elasticity in any way given to the rolling stock also favorably affects the resistance of the rails.

However, if the supports have the same elasticity in summer as in winter, as, for instance, would be the case with granite rock, then Professor Styffe asserts that the same rails, either of iron or of steel, can resist a heavier blow from a falling ball at the temperature of extreme cold than on a hot summer's day. Although the experiments have been conducted with the utmost care and skill that science and money can afford, it seems desirable that this theory should be proved on a larger scale than Professor Styffe has had an opportunity of doing, before it can be relied upon.

At a meeting of engineers, at Stockholm, in March, 1867, it was decided that Bessemer steel rails, made from charcoal pig iron, might, without risk, be used 10 per centum lighter than the English iron rails, and in Austria this has already been practiced with success by the engineer-in-chief, Wöhler.

It must, however, be observed, that the raw material used in both cases is charcoal pig iron of a superior quality as compared with that used in England for making Bessemer rails, which may be seen from the following analyses made by two eminent chemists:

Analyses of Swedish and English pig iron.

Bessemer Swedish pig iron, Fagersta Works. Analyzed by Kohlberg.	Per cent.	English Bessemer pig iron, Workington, Cumberland. Analyzed by John Percy.	Per cent.
Graphite	2.733	Carbon	2.993
Combined carbon	2.138	Silicon	3.080
Silicon	0.641	Manganese	0.079
Manganese	2.926	Sulphur	0.021
Sulphur	0.015	Phosphorus	0.081
Phosphorus	0.026		

These analyses show that the great difference between the two is the excess of silicon in the English, and of manganese in the Swedish pig

iron; thus explaining why the one gives a better result than the other, although worked entirely without the addition of spiegeleisen.

If there be only 0.6 per cent. of carbon in the solid steel, and 0.3 per cent. in the steel for the steel head, the safety ought to be the same for all the three kinds, and this would not influence the former calculations as to which is the best and most economical material for rails.

Having watched the development of the Bessemer process in England, as well as on the continent, it seems to the author that by that process a good and pure raw material has the same advantage over an inferior one as in all other processes, and that a superior product cannot be obtained from an inferior raw material by that process any more than by others. In having mentioned Swedish material, as an example, it must not be supposed that it is wished to advocate the use of Swedish iron in this country, but simply to draw attention to the better material, as equally good charcoal iron can be supplied from Canada and India, both English colonies. It may also be remarked, that the author's endeavor has been to arrive at the truth irrespective of prejudice, and that he has no wish to be deemed an advocate for one kind of rail more than any other.

APPENDIX G.

LAW OF LIVRET IN FRANCE.

INSTRUCTIONS AS TO THE LIVRETS OF WORKMEN.

PREFECTURE OF POLICE, 1ST DIVISION, 4TH OFFICE, 2D SECTION,
Paris, October 15, 1855.

GENTLEMEN: In order to respond to wants strongly felt in the industry of the country, the government of the Emperor has presented and had adopted by the legislative power a law as to the discharge of workmen. This law was promulgated the 22d of June, 1854, and was followed by an imperial decree designed to regulate its application, and bearing date the 30th of April, 1855.

I have prescribed by an ordinance of police, dated this day, the publication in the department of the Seine of these two acts of the sovereign power, of which I have to enforce the execution, with your assistance.

It is my duty, in notifying you of the new regulation, to make you appreciate its full importance, and to facilitate your study of it by a few general instructions.

The *livret*, which the ill-disposed have sometimes sought to discredit and render unpopular, is an institution beneficial and protecting to the workman. It assures to him the support of authority, and becomes for him an incontrovertible title to confidence and esteem. Far from being an assault on his liberty and dignity, it has marked the emancipation of industry, of which it has been the consequence, and, as it were, the declaration.

The law of the 22d germinal, year XI, which created this institution, at least in its present form and effect, is due to the genius of the First Consul and the collaboration of Chaptal. This law has remained as the true code of labor, which it has regulated with a profound understanding of the wants and conditions of modern industry. However, time had revealed certain deficiencies in this first regulation; and, on the other hand, the rapid development of French industry had brought new wants, for which the last government had tried to provide by presenting various projects to the chambers, none of which have become a law.

It remained for the Emperor Napoleon III to complete the work of the First Consul. It is this which he has now done in endowing the national industry, which already owes so much to his reign, with a legislation vainly demanded for twenty years.

Faithful to his constant solicitude for the laboring classes, the Emperor has been pleased to attach new favors to the institution of which we speak. Henceforth the *livret* will take the place of passport in the interior. It will be a necessary title to participate in the election of the *consul des*

prudhommes: in short, it will remain in the possession of the workman and serve as permit of residence and for all other papers of surety, instead of being deposited, as formerly, in the hands of the chief of the establishment.

By the last innovation, of which he has personally taken the initiative, the Emperor has wished to honor the position of the workman, and to give to his relations with his employers that character of equitable equality which, hitherto, they have not had. One cannot doubt that such proofs of interest will touch those who are the object of them.

I owe you, gentlemen, these preliminary explanations, which will serve to make you grasp the spirit, general tendency, and liberal character of the new law. They are, moreover, the natural prelude to the examination which I have to make with you of the provisions, purely administrative, of which you are to second the application. I now enter on this examination, which, for greater clearness, I will divide into a certain number of paragraphs.

1.—PROFESSIONS AND WORKMEN TO WHOM THE USE OF THE LIVRET APPLIES.

The first article of the law of the 22d of June has for its object to generalize the usage of the *livret* without making it go out of the circle purely *industrial.* It extends the application of this institution to professions which had remained outside of the prescriptions of the law of the year XI.

The terms of this article are clear and precise. A few explanations, however, will not be improper. For example, it mentions, as under the obligation of the *livret*, the work people of both sexes. This provision is new and delicate. It should be applied with a wise reserve, and confined within the limits fixed by the legislature itself. Observe here how the government explains itself in this particular in the statement of the motives of the law:

"Since the year XI the large manufactures have very greatly multiplied, and the employment, every day more extended, of mechanical means, has permitted women to accomplish in these establishments tasks which, before, were interdicted to them. In this respect, moreover, it is not a novelty which the law proposes. There exists a certain number of factories where women have a *livret* as well as the men, and practice has shown that this usage presents only advantages."

On his part the reporter of the commission thus expressed himself before the Corps Legislatif:

"Your commission has rejected a provision which would have extended to domestics, day laborers, *dressmakers* and *seamstresses*, working by the day, and all persons in respect to whom the execution of the law would be, so to speak, impossible, and whom it was not the intention of the government clearly expressed by its statement of motives to make subject to it."

These observations determine the sense of the law. To speak properly, the legislature has wished, with regard to women, merely to sanction the pre-existing usages, and all shows that it had particularly in view the work people of factories, and those who exercise an *industrial profession*, properly so called.

It is within this limit, for the present at least, that I shall cause the law to be executed. It will be proper, therefore, that you abstain from all initiative in regard to female operatives hitherto not subject to the use of the *livret*, limiting yourselves to facilitating the procuring of this title by those who seek it voluntarily. It will only be after a certain time of experience that the administration will be able to fix its jurisprudence on this point.

There are certain professions which resist the adoption of the *livret* by claiming for those who exercise them the quality of *artists*. The law furnishes on this pretension a very simple means of solution by making the *livret* an electoral condition for the formation of the *consul des prud-hommes;* every individual who will have or who would like to take part in this election will be held to the obligation of the *livret*.

On the other hand, some have submitted at times to this obligation under pretext that they have no *patentes*—persons working directly for the consumers without intermediates. This is an error; these persons are not operatives; they are manufacturers, *patented* or not.

2.—Of the giving of the livrets.

In future the *livret* may not be obtained except on the production of an act certified by you conformably to the 2d paragraph of the 4th article of my ordinance. You will have, therefore, in the delivering of the *livrets* an essential part to perform on the subject of which I should enter into some details.

For a long time complaints have arisen about certain frauds which reduced the *livret* to a useless formality; these frauds arose from the facility with which the unfaithful workman could obtain a new *livret* after having left a previous one in the hands of an employer whom he had cheated. To put an end to this manœuvre the various projects presented to the chambers had surrounded the delivering of a *livret* with a long series of justifications in some respects fortified by the sanctity of an oath, by means of which it was hoped to assure at last the right of this title.

This was an error. For all that they were so minute, such precautions remained always impotent to prevent all the frauds, and they had the serious inconvenience of multiplying the formalities to the extent of becoming arrogant and vexatious for the mass of honest workmen. The new law proceeds by quite different means and infinitely more equitable and worthy. Instead of detailing a series of requisites, narrow and exclusive, it confides in the prudence of the administration as to the guarantees to be required; it supposes the good faith of the workman, and

gives him every facility for obtaining a *livret;* but it punishes bad faith and visits with a correctional penalty manœuvres and false declarations, of which, moreover, it secures the evidence. It follows from this system that in the exceptional cases where the workman is not in a position to conform to the usual requirements, he can obtain a *livret* by a simple declaration signed by him, but at his risk and peril, and under the sanction of article 13 of the law of 22d of June, *which should be read to him beforehand.* Such is the provision of article 3 of the decree of the 30th of April, to which I invite you to refer each time that you may have to make application of it. In prescribing the reading of the penal text, the decree has sought to prevent a provision altogether benevolent toward the workman from becoming a snare for his inexperience. This formality is therefore an act the omission of which would involve your conscience and your responsibility.

You will remark that the provision which I have just mentioned is in nowise intended to set aside the conditions and guarantees hitherto required. It will only be under rare circumstances that it will be necessary to rest on the simple declaration of the candidate. But in ordinary cases you will have to require of the workman who solicits the certificate required by article 4 of my ordinance the proof of his identity and of his industrial position. This last proof will be given in future before you; it consists in general of the production of a discharge from apprenticeship, of certificates of labor given either by the former master or by the one who desires to employ the candidate, or, in short, of other similar documents.

Supposing the seeker to produce proofs of this nature or to demand the benefit of article 3 of the decree of the 30th of April, it will remain for you to fulfil his demand. I have had printed a form of certificate which it will be your duty to deliver, and copies will be furnished to you *provisionally* by my prefecture. This will be filled out by the commissioner of police of the *place of residence of the workman.* As I have said, it will be indiscriminately required of all workmen who demand a *livret,* be he even a native of Paris. As to the documents of proof and the certificates of labor, they will continue to be legalized by the commissioner of the place of delivery, and they will be presented to the functionary who receives the request for the *livret* and who gives the certificate.

3.—Registration at the prefecture of livrets obtained in the departments.

Article 2 of the decree enacts that there will be kept in each commune (at the prefecture of police for the department of the Seine) a register on which will be recorded at the time of their delivery the *livrets* and visas of travelling. This is a measure which interests the good direction of the service; but it would remain ineffectual in a centre like Paris if it limited itself to the recording of *livrets* obtained at the prefecture of police; also by the terms of a very old provision, reproduced in article 6 of my ordi-

nance, the *livrets* delivered in the provinces must be equally registered at my office before they can be made use of in the province of the prefecture of police. This formality is shown by a special visa. I recommend you to see carefully to its execution.

4.—Use and visa of the livrets.

The new regulation makes no change in the jurisprudence followed at Paris as to the use and visa of the *livrets*. You will have therefore merely to follow in this respect the established traditions which are specially mentioned in articles 6, 7, and 8 of my ordinance.

Thus the workman cannot be admitted into an establishment except on the presentation of a livret. He cannot leave this establishment except after having obtained a regular dismissal, and he must within the twenty-four hours of his leaving submit this dismissal to your visa. It is only after this formality that he can be received by a new employer under penalty of prosecution of the latter, except in the case that will be mentioned hereafter, of home workmen. On his part, the employer cannot receive a workman unless as the latter is furnished with a livret in proper condition. He visés this *livret* at the entry of the man, records it on his register, and submits it within the twenty-four hours to your own visa.

After such visa given by you, you are to address to me an abstract in the form of a printed bulletin, of which you will continue to demand from my office the blanks which you may require. The sending of this bulletin, neglected of late, must be recommenced. I attach a real importance to it. I shall take care that this measure be strictly executed, and I count on all your vigilance in this respect.

You will notice that the bulletin of which we speak should relate the advances with which the livret may be charged. Please recommend this detail to the attention of employers.

5.—Distinction of the two categories of workmen subject to the livrets.

I come now to one of the most important provisions of the law, and one at which it is the more necessary to stop, as it is new and of a complex application.

Hitherto the majority of artisans working at home and known under the name of home workmen, *(ouvriers en chambre,)* have remained without the use of the *livret*. This was a deficiency to be filled up; but there arose difficulties of which the former laws failed of the solution. Of the home workmen, there is no hesitation as to those working for a single establishment, to which they are really attached. They should be subject to the *livret*. But others, working simultaneously for several employers—how can the ordinary obligations which the use of the *livret* entails be reconciled with such a situation? The legislature of 1854 has not allowed itself to be hindered by this objection. It has considered that the benefit of the *livret* consisted before all in its very existence.

Consequently, it has prescribed the employment of it indiscriminately for all workmen, dispensing, in favor of those working for several masters, with formalities incompatible with their position. The law distinguishes, therefore, two classes of workmen subject to the use of the *livret*, but with different obligations:

1. Those attached to a single establishment and employed only by it, whether they work in this establishment itself or outside.

2. Those working habitually for several establishments and employable by more than one master at the same time.

The first can only be admitted into a new establishment on proving their integrity by a dismissal or certificate of departure from their previous employer; the others are relieved of this formality, and obliged simply to have their *livret* viséd at the commencement by each employer who hires them *for the first time.* You will find these distinctions clearly defined in acts 7 and 9 of the decree of the 30th April.

By the terms of the second paragraph of the first article of the same decree, the *livret* must state to which category the workman belongs. Again, article 9 obliges the chief of the establishment who receives a workman to mention, as well on his register as on the *livret* of the said workman, in what capacity he employs him.

Thus the character or category of the workman is determined by the *visa of entry* which the employer of the two categories is obliged to enter on the *livret* at the time that he employs this workman; and since the obligations and rights of the workman and employer vary according to the category to which the former belongs, it is of the last importance to observe in the visas the fundamental distinction which has just been indicated.

To render this distinction more apparent, I have ordered forms of visas which I invite you to have adopted by the chiefs of establisments. They are as follows:

1.—*Visa of entry for the workman of the first category.*

"Admitted by me as workman attached to a single establishment.
PARIS, the ——— ———, 18—."
(Signature and residence of employer.)

2.—*Visa of entry for the workman of the second category.*

"Employed by me as workman, working habitually for several establishments.
PARIS, the ——— ———, 18—."
(Signature and residence of employer.)

3.—*For the dismissals or certificates of departure.*

"Discharged, free of obligations, the ——— ———.
PARIS, the ——— ———, 18—."
(Signature and residence of employer.)

You have already understood, gentlemen, that that which I have now said of the indication in the visas of the category to which the workman belongs, applies to the certificate which you have to deliver for the procuring of a *livret*.

Finally, it is evident that the workmen of one category can pass into the other with the same *livret*. This change is shown in full force by the visa of entry. But here there is a remark to make: if the workman pass from the first category into the second, he must in the first place prove the accomplishment of his engagements towards his last master, while he is held to no proof in order to pass from the second category to the first.

6.—Register to be kept by the chiefs of establishments.

The law of the 22d of June contains still another innovation, of which you will easily understand the importance: it prescribes to the chiefs of establishments the keeping of a special register, in which he shall enter the name and position of each workman whom he employs. Conformably to article eight of the imperial decree, and of the delegation contained in article ten of my ordinance, this register will be numbered and countersigned by you; but you will address to me for each countersigned register a bulletin, bearing an abstract of your minutes; printed copies of these bulletins will also be supplied to you from my prefecture.

You will open with each of your commissariates a register, in which you will enter the chiefs of establishments whose private registers you have countersigned.

These latter registers are not subject to any periodical visa; still they will be communicated to you upon requisition, without being removed from the establishments themselves. It has appeared to the council of state that this provision will sufficiently facilitate the exercise of your supervision.

7.—Penal sanction—execution of the law.

Having fixed all the points of this important regulation, the legislature has wished to insure the execution of its work by attaching a penal sanction. The penalties which it has ordered are moderate, in view of the nature of the things, but sufficient in the hands of a vigilant administration. Henceforth, every infraction, either of the law itself or of the legal regulations on the matter, *will constitute a punishable offence.* Thus a deficiency is filled up which compromised seriously the preceding legislation.

I have only, gentlemen, to appeal to your zeal and experience to insure the reorganization and regularity of a service which I consider among the most important. I have reason to believe that, by means of the influence which the confidence of your people gives you, you will succeed in general in the usual way in obviating offences and prosecutions. It is my desire; but when, thanks to your counsels and your benevolent

directions, the law shall be known and understood, you will have to search attentively, and report to me the infractions which may be committed against these wise provisions. The multiplicity of our relations with the industrial population, the keeping of the register of the employers, the visa of the *livrets*, their usage as papers of surety, will be to you so many opportunities and means to exercise a control which ought not to permit any violation, if it is done with the perseverance which I expect from you.

After having excited your zeal and your ordinary devotion, I conclude, gentlemen, by making an appeal to your prudence. You have to make the application of delicate measures; some of them excite susceptibilities, which it is necessary to allay or avoid; others are new, and will permit, especially at first, a wise reserve; all require tact and moderation. I hope that under these circumstances you will know as usual how to ally, in a just measure, prudence to firmness, and that you will contribute powerfully to assure the success of a regulation which ought to be a new title for the government of the Emperor to the recognition of the country.

I beg you to acknowledge the receipt of this circular.

Receive, gentlemen, the assurance of my perfect consideration.

PIETRI,
The Prefect of Police.

By the Prefect:

A. DE LAULXURES,
The Secretary General.

APPENDIX H.

EVIDENCE GIVEN BY ABRAM S. HEWITT BEFORE THE TRADES UNION COMMISSION IN LONDON, IN 1867.

1, PARK PROSPECT, WESTMINSTER,
Tuesday, July 16, 1867.

Present: The Right Hon. Sir William Erle, the Right Hon. the Earl of Lichfield, Lord Elcho, M. P., Sir Daniel Gooch, Bart., M. P., Herman Merivale, esq., C. B., James Booth, esq., C. B., Thomas Hughes, esq., M. P., Frederic Harrison, esq., William Mathews, esq.

The Right Hon. Sir William Erle in the chair.

Mr. ABRAM S. HEWITT further examined.

By the CHAIRMAN:

Q. I think you propose to say something on the general conclusion at which you have arrived with reference to the subjects on which you have been examined here?—A. Yes; I propose to add, as the answer to a question which Mr. Mathews put to me, the conclusion which I intended to utter at the time, but which probably passed from my mind in consequence of some interruption. Mr. Mathews said to me, "Is there any other information with which you could furnish us which you think would be of use to this commission?" And my reply then was to this effect: "I am going back to America, and will then be very happy to collect the information and send it to the commissioners;" and I stated then "It is not a question of master or workman, but of the public welfare." Now to that question I desire to add this conclusion: "The general conclusion at which I have arrived is that the effort to produce commodities at the lowest possible cost, in Europe generally, has led to the employment of juvenile and female labor to an extent and in a manner not consistent with the laws of humanity and the best interests of society; that the employment of this kind of labor has had the effect to reduce the standard of wages generally, and, instead of adding to the resources of the family, has simply secured the labor of the entire family for the wages which would otherwise have been paid to the head of the family, if he alone had worked for wages. This system is a leading argument against free trade in countries where the men only work out of the household, and generally tends to reduce the condition of the laboring classes all over the world. The restraining acts now in force in England with regard to the employment of children is a step in the right direction, and if other countries, such as Belgium, France, and Germany, could be induced to co-operate, the condition of the laboring classes in Europe could be greatly improved, although the cost of particular commodities

might be slightly increased. But the production of cheap goods may be secured at too great a sacrifice, if it be at the expense of the comfort and moral tone of the working classes; and this appears to be the point at which you have arrived in England, and against which there is an instinctive rebellion, both among the enlightened and the ignorant, manifesting itself among the latter in organizations at war with the fundamental principles of social order, such as trades union associations."

By Mr. MATHEWS:

Q. That is simply an extension of the answers, though embodying a little more matter, which you have given previously?—A. Yes, that is my idea.

By the EARL OF LICHFIELD:

Q. Are you aware whether trades unions have ever taken any steps to prevent the employment of children under a certain age?—A. I have no knowledge on that subject.

By the CHAIRMAN:

Q. I believe you have another matter which you desire to mention?—A. I desire to correct my testimony upon certain points. I testified that the eight hours law had been passed by the legislature of the State of New York, but had been vetoed by the governor. I was so informed at the time that I gave the testimony, but within two days after the testimony had been given I received information from home that the governor had signed the bill; so that all that portion of my testimony which is in commendation of the governor for his firmness in resisting that law is out of place; he has actually signed the bill, and received the thanks of the working men for having done so. This is the form, therefore, in which my testimony ought to stand: "I am advised that the governor of the State of New York has signed the bill making eight hours a legal day's work in the State of New York, and that it is now a law."

By Mr. MERIVALE:

Q. You have no objection to its standing as your deliberate opinion that trades unions in themselves, whether conducted moderately or immoderately, are absolutely "at war with the fundamental principles of social order?"—A. I speak of trades unions as I understand them. I can imagine that trades unions for another purpose would not be at war with the fundamental principles of social order. I refer to trades unions that undertake to lay down the conditions upon which labor shall be bought and sold in the market.

By Mr. BOOTH:

Q. Is it your opinion that the eight-hour law will be acted upon in the State of New York?—A. I am now prepared to give some testimony on that subject. The passage of the eight-hour law in Illinois was followed by a general strike of the workmen in Chicago for eight hours' labor with ten hours' pay. That failed, as a matter of course, and they

have resumed work in Chicago at ten hours a day, or in some cases at eight hours a day with 20 per cent. deduction from the wages, making it an equivalent compensation for the time. In New York the workmen have not struck, but instead of that they held a convention in the city of Albany, which is the capital of the State, and in that convention, after a great deal of discussion, they resolved that after the 1st day of November next no member of a trades union would work more than eight hours per day for a day's labor, but that they would accept 20 per cent. deduction on the wages which they were receiving for ten hours; so that the question now is simply the question of working eight hours at an equivalent rate of wages to the rate received when they worked ten hours, and they have resolved to put that in force on the 1st day of November next.

Q. In what form does the act limit the day's labor to eight hours?—A. It simply declares that, in the absence of any provision to the contrary, a legal day's labor shall be eight hours; so that if I contract with a man for a day's work at any given sum he is bound to give me eight hours' labor for that sum, and I am bound to accept eight hours for that sum; but there is nothing in the law to prevent a contract for more hours and a different rate of wages. I have brought with me the resolutions which were adopted by this convention. I do not know that the commission wish to hear them, but they are brief, and I brought them for the purpose of showing in what form these matters are coming up in our country. I testified before that I thought that trades unions had not reached so great a degree of development in America as here. I still think that in details they are less perfect, but I find now, on investigation, that every trade is organized into local trades unions, and that they have general conventions or assemblies which lay down the laws for the local unions; that in every one of the northern States these conventions exist, and that they have just now called a national convention to meet at Chicago in August next to organize a national labor party, with the intention, doubtless, that they shall run candidates for public office.

Q. When you say the trades unions are less perfect in America, do you mean that their control of the labor market is less effectual?—A. I think we have not felt it as you have felt it; my idea is that they have not reduced the thing to so perfect a system of watchfulness over the members; but I do think that the organization now pervades the whole of the northern States, and almost every branch of industry. Of course I have been getting information since I was last here on these points, and I find that the thing is much more perfect in America than I supposed at the time I gave my testimony.

By Mr. MATHEWS:

Q. Have you considered whether the ulterior object in demanding that eight hours shall be a day's work is to attempt by and by to get the same wages for eight hours as are now given for ten hours?—A. I have not the slightest doubt that that is the aim of the workingmen. They first

tried to get the same wages for eight hours as for ten hours. They failed in that, and now there is no doubt that, in establishing the eight hours, they look forward to having the same wages as they now have for ten hours.

Q. Eight hours is what you call in America the platform of labor?—A. Yes.

Q. And eventually their object is to get the same wages for eight hours as previously they had for the longer time?—A. Yes. I should like to put these resolutions to which I have referred in testimony; and if you will allow me to read them, I think they will give you the best idea I can possibly give, from the workmen's mouths themselves, of the present state of opinion among them in the United States.

By Mr. BOOTH:

Q. They will show us what the workmen are, in fact, aiming at?—A. Yes. This is the report of the committee, which report was adopted, I may say, by the convention: "Your committee, to whom was referred the all-important subject of good and welfare of this body;" this being a convention of the working men.

By the CHAIRMAN:

Q. Simply as workingmen, not as working builders only, for instance?—A. No; a convention of delegates representing the various local trades unions in the State of New York, so that it is practically a parliamentary body: "Whereas the legislature of the State of New York did, at its session, pass an act entitled the eight-hour labor act, making eight hours a day's work in the absence of any contract; and whereas it is only just and proper that the workingmen of our State should enjoy the benefits intended to be conferred by said act; and whereas our employers, as a body, have shown an unexpected hostility to the adoption of the eight-hour system, even though we should concede a corresponding reduction of wages, and notwithstanding the fact that we have an eight-hour law, so called, have not enforced it, but still continue to work their employés as heretofore, and to cause the convicts in our prisons still to be worked ten hours: Therefore, *Resolved*, That wishing to do equal and exact justice to all men, and being extremely anxious to avoid all trouble or cause of disagreement between ourselves and our employers, we will insist upon no extreme measures, nor act in a manner calculated to entail loss upon those who employ labor. *Resolved*, That in order to give our employers ample time to fill all contracts predicated upon the present system of labor, we will not insist upon the adoption of the eight-hour system until the —— ——, and that, commencing with that date, we will work eight hours for a day's work, at a reduction of twenty per cent. of the rate of wages then paid, and that all time worked over eight hours shall be paid for at the rate of time and a half time. *Resolved*, That whether we are successful or not in our present efforts to secure the hours of labor, we will still continue to advocate this reform, and, having full confidence in

the justice of our cause, we will never cease to advocate it until we secure its adoption throughout the entire continent." The report was accepted and the question was deferred for further action; then, finally, the report was adopted, and the time filled in the 1st of November next. That is the platform which they adopted. And then there is a resolution "for a committee to wait upon Governor Fenton, and ask him to issue a proclamation declaring that eight hours is a legal day's work on the public works, in conformity to the law of last winter;" and that was adopted.

Q. The "public works" means works on which convicts are engaged, I suppose?—A. The public works with us, I should think, would mean canals and public works which belong to the State. I should doubt whether they mean works in the State prisons, but it is quite evident that they do contemplate reducing the labor of the convicts in the State prisons.

By Mr. MERIVALE:

Q. Can you at all form an estimate of what proportion of the population in such a State as the State of New York, among those properly called working men, would be men who would take part in these unions?—A. The percentage would be quite small of the whole number, but I should not like to make an estimate now.

Q. It would be larger, I presume, in New York than almost in any other State, except in the New England States?—A. I think that in the eastern States, New York, New Jersey, and Pennsylvania, and the New England States, the percentage would be larger than elsewhere; but I think that of the whole number of the population, the number that belong to trades unions would be comparatively small. It would be a guess, as we say, an estimate, but I cannot imagine that it would be more than ten per cent.

By Mr. MATHEWS:

Q. Have you ever considered, supposing that this scheme for limiting labor to eight hours a day is carried out and acted upon, and that other classes find it necessary to limit themselves to eight hours a day, namely, merchants, lawyers, public functionaries, &c., what the effect would be upon society?—A. I suppose that if there were a general reduction of the hours of industrial work or other work, there would be a reduction of production, that the work would have less stock to distribute among its various members, and we should all be poorer in consequence.

Q. Beyond that, would not the effect of having sixteen hours' idleness act very prejudicially upon the morals of the community?—A. I think that it depends very much upon the training which the man who has the leisure has received. I can readily understand that a man like Charles Lamb, when relieved of his work at the India House, found it very profitable to have leisure time. Many people would use the leisure well, while other people might waste it in dissipation. But that is a matter of training. I think that if the working men had a perpetual holiday, without

any preliminary training, they would plunge into dissipation and vice; but, on the other hand, if they had been trained to artistic and intellectual pursuits at some portion of their lives, they would make good use of their leisure.

Q. But men like Charles Lamb do not abound?—A. I agree with you, and I cannot lay down so broad a proposition on the subject as to include all. I think, as a general rule, that people become vicious and dissipated when idle, and that they are happy when they are fully employed.

By Mr. HARRISON:

Q. Do you think that, with the progress of civilization, (supposing civilization to progress in a reasonable manner,) working eight hours a day would be less favorable to the general condition of the workmen and of the world than working ten hours a day?—A. I cannot say that it would. I have to apply all these questions to my own feelings and my own case, and I should say that I would consider it a very desirable thing personally to be relieved from close attention to the business out of which I get my livelihood at the end of eight hours, and I could employ my time profitably in other ways. I cannot say that I think a reduction of the hours of labor would be injurious to society; but I can say that I think that a reduction of the hours of labor would be injurious to society, unless it were accompanied with proper training.

By Mr. MATHEWS:

Q. Unless, in fact, the virtue predominated over the vice?—A. I think that everybody must be trained for leisure.

Q. To adopt the leisure, without a previous preparation for it, you think would be injurious to the welfare of any society?—A. Yes.

Q. You spoke of women and children, and you stated that you considered that the labor of women and children should not be brought into operation, because it tended to reduce the rate of wages generally. Have you ever considered whether it is not necessary to employ children in order to have skilled adult workmen hereafter?—A. The process of industrial education, of course, must begin at some time or other in life.

Q. Do you mean by education simply a school education, or education for a man's after occupation in life?—A. By education I mean both intellectual education and industrial education; that is to say, the education of a man in his trade. I think that there is a time when both of those should commence, and I think that the intellectual education should begin before the industrial.

Q. Do you think that the industrial should begin during childhood or boyhood?—A. I think it is very desirable that it should.

Q. So that, if you were to throw out of employment children of a certain age, you would cut at the root of the process by which skilled labor is got, both in this country and America?—A. I think that if I were to assent to your proposition I should be doing injustice to myself and injustice to the question. I clearly think that the young should be trained

for industrial pursuits; but I think that for them to be confined and restricted to industrial pursuits, that is to say, to receive no other education but an industrial education, and especially the hard kind of labor I have seen them subjected to here, is decidedly wrong, and it is in that point of view that I make my criticism. I do not object to industrial education, but I object to it to the exclusion of other education. I see children put to work in Europe at a very early age, and being kept at it always, they lack the other training which I think is indispensable to fit them to deal with just such questions as we are now dealing with.

By the EARL OF LICHFIELD:

Q. At what age do you think that that industrial education should begin?—A. In our country, as a matter of practice, we usually begin at fourteen; but at Paris I have seen schools, under the *Frères de la Doctrine Chrétienne*, in which the trade instruction and the intellectual instruction goes on together, and there they take children as young as eight; but both branches are taught in the same schools.

Q. In that case, how is the time divided between the industrial education and the intellectual education?—A. Four hours is given to the intellectual education and eight hours to the industrial training.

By Mr. MATHEWS:

Q. Is it all done under the same roof?—A. Yes.

By Mr. HARRISON:

Q. Are you referring now to children of eight years of age?—A. They begin at eight years of age.

By Mr. MATHEWS:

Q. Would it be practicable to carry on that process with the generality of the trades in England? Take the iron trade, for instance?—A. I should say that it would not be practicable in the iron trade. They have been compelled to select a few of the artistic branches of business, such as the manufacture of opera-glasses, trunk, frames of pictures and looking-glasses, and things of that sort, things mainly connected with the artistic business of a large society. I think that a system of education is quite possible in iron works, because at Creusot, one of the largest iron works in the world, I found that the children were all instructed in the schools, and that the education was of a class to fit them to become iron workers; for instance, they were taught arithmetic, reading, and writing and drawing, and the girls sewing. They were careful, and I think wisely so, not to carry the culture beyond the purposes to which these children were required. Music they were taught also.

By the EARL OF LICHFIELD:

Q. At what age do the children commence working at the iron works in your country?—A. In our country the youngest will be found among mines, and I know of no case where they are under 13 or 14 years of age. The work they do there is usually to drive a horse.

Q. And do you think that, beginning at 13 or 14 years of age, they can obtain that amount of training which is necessary to enable them to become efficient?—A. I have no doubt of it.

Q. Of course the iron works are kept open night and day?—A. Yes.

Q. Are the children at that age, 13 or 14, employed during the night, like the others?—A. They are compelled to work at night. They are the catchers around the small trains; for example, it is necessary to have small boys, because they are quick and active to catch the rods, and for that purpose they must be there night and day.

Q. That you find is necessary?—A. That I find is necessary, and, according to my observation, not injurious.

By Mr. HARRISON:

Q. In the addition you have made to the evidence given on the last occasion, you have said something about the general character of unionism as you have observed it. Speaking generally, to what are you disposed to attribute the origin of unions; to what general cause do you suppose that unions are due?—A. I have stated in my testimony previously that I believe that this restlessness and uneasiness which exist among the laboring men all over the world, and especially among those who are more enlightened, arise from two causes; one of those is the general introduction of machinery, by which production has been enormously increased without (as the people believe) a corresponding rearrangement of the laws of distribution of the proceeds; it is a feeling arising out of the belief that the profits of industry are not distributed fairly. That is the first cause. Secondly, the large introduction of gold from California and Australia has disturbed the relation of value, and labor, among other commodities, has had its value disturbed. It is reaching an adjustment which it would reach without the trades unions, but which these working men believe they will reach more readily by the trades unions.

Q. Then you believe that the existence of trades unions is a result of far more general causes which exist among the working classes as a whole?—A. I think that the trades unions are a symptom of the readjustment of the relations of capital and labor. The production and the industry of the world have outgrown the principles to which we have been trained; and the world is now engaged in readjusting these questions. And I am confirmed in that view by these facts: I find that this restlessness seems to prevail just in proportion to the intelligence and the wages of the working men; the more intelligent they are and the higher wages they get, the more restless they seem to be. In France, for instance, on the other hand, where I found the workmen much more ignorant than here, I found much more contentment. The contentment seems to be in proportion to the ignorance, in other words.

Q. Have you found analogous tendencies and similar objects to those which trades unions show are at work in the working classes to exist among those who are not members of trades unions?—A. Yes; I think that there are a great many who are not members of trades unions who

are striving to reconstruct the industrial system upon another basis; that is to say, the co-operative basis; and in Germany, especially, they have made considerable progress in that direction.

By Mr. MERIVALE:

Q. You refer to the Schultze-Delitzsch movement?—A. Yes.

By Mr. MATHEWS:

Q. Do you think that the discoveries of gold in Australia and California have so acted as not only to have increased the value of commodities generally, but that the value of labor has not increased in proportion to the value of other commodities?—A. I am not certain that it has not, and if I estimate it now by the results to be gained by the employment of labor in England, the United States and on the continent, I am inclined to think that labor has got its fair share because I know of no staple commodity which we can produce in the United States at a profit, and I am assured by those connected with the iron trades here that it is the case here also, and on the continent I find the same. Hence all this immense development of manufactures is, to-day, without advantage either to the proprietor or (if the workman is to be measured by his contentment) to the workman, though perhaps the world has gained by the cheap rate at which they get the commodities.

Q. The workman, in entertaining the impression that all other descriptions of value having risen, his labor is not sufficiently remunerated, may be right or wrong, but hence arises the organization of trades unions for the purpose of accomplishing what cannot be accomplished by a natural process?—A. I think that that has very much to do with the wonderful extension of trades unions.

Q. And the movements of large bodies of working men are not generally governed, I presume, by that philosophical reflection that the movements of the higher classes are governed by?—A. I would not like to state that proposition, but I would put it in this shape, that the more enlightened and experienced people are, the wiser their movements are likely to be. It may be that the workmen are wiser than their employers. I should like, in answer to that question, to read one resolution which was adopted at Albany as showing the feeling among the working men: "Mr. O'Donohoe read some resolutions setting forth that the interests of capital and labor are antagonistic, and that therefore it is highly advantageous to workmen to become employers. It therefore calls attention to co-operation as the true mode of settling disputes between the two classes, and urges mechanics to form co-operative shops. Mr. O'Donohoe said that he had tried co-operation for some time, and he was well satisfied with it. His shop embraced about 40 men in the moulders' trade, and he thought that all troubles had been finally adjusted. The resolutions were adopted." There is a resolution setting out broadly that "the interests of capital and labor are antagonistic." Now, in answer to the question whether intelligence is likely to come to more sound conclusions

than ignorance, I answer yes; and I give this as evidence of it. Here is a resolution of the working men, setting out that "the interests of capital and labor are antagonistic."

Q. A resolution cutting at the root of all society, in fact?—A. Yes.

By Mr. MERIVALE:

Q. Your opinion is that the fall in the value of gold has affected the price of wages generally?—A. I think it has.

Q. Is anybody ever paid in gold in America?—A. At present not, but formerly they were paid regularly in gold. Since the war, that is to say since 1862, no one has been paid in gold.

Q. Do you suppose that the fall in the value of gold affects a currency of paper?—A. For example, a dollar in gold to-day will purchase one dollar and forty cents in currency in the United States. If gold should fall in value to-morrow, less than a dollar and forty cents in currency would buy a dollar of gold.

Q. No doubt that is so; but do you think you can generally answer that a currency in paper is depreciated by reason of a depreciation of gold?—A. I think that if gold depreciates, paper will appreciate with the fall in gold.

Q. You say that in your opinion a movement for eight hours as a day's labor means ultimately eight hours' labor at the same wages which ten hours' labor now gets?—A. I have no doubt that is the aim of the men, and that they think they can succeed.

Q. Do you think it probable, supposing they should succeed in reducing the hours of labor to eight, that men would become able to do in eight hours what they now take ten hours to do?—A. I think not. There are some branches of business in which they could, but if you take the iron business for example it cannot be done, because there is a question of revolutions of trains, and of course the yield is proportioned to the number of hours that the trains are kept in motion.

Q. But in cases where the gain depended on the energy of the men alone, do you think that if you reduced the hours of labor to eight they would be able to do as much in eight as they now do in ten hours?—A. I think there are cases in which eight hours' labor would be as good as ten, but if you or I had a piece of hard intellectual work to do, which was going to take us a month to accomplish, I think that we should be likely to accomplish it as well with eight hours' work a day as with ten. I think that that is the experience of all men who have that kind of work to do.

By Mr. MATHEWS:

Q. In all manual labor, or where strength and skill are required, would it be possible to do as much in eight hours as in ten?—A. I think not.

Q. As a law, therefore, a reduction by one-fifth of the hours of labor would involve a reduction by one-fifth of the production?—A. As a law, I think that it might be stated in that way.

By Mr. BOOTH:

Q. The energy that is brought to bear upon piece-work would be an important element, would it not?—A. Yes; in piece-work, in many cases, the men would do as much in eight hours as they ordinarily do in ten without piece-work. But, again, that would not apply to many branches of the iron business, because there is a positive question of time and nothing else, as, for instance, where a man has to watch a machine going.

Q. As a general rule, more would be done in ten hours than in eight hours?—A. As a general rule more would be done in ten hours than in eight hours, but I think that the general result of piece-work is to increase the quantity done in a given time.

By Mr. HARRISON:

Q. Going back to a former subject from which we have wandered, you say that you seem to see in England something like a species of rebellion, of which unions and unionism appear to be one example?—A. Certainly.

Q. You say, "This appears to be the point at which you have arrived in England, and against which there is an instinctive rebellion, both among the enlightened and ignorant, manifesting itself among the latter in organizations at war with the fundamental principles of social order," under which "organizations" you include unions?—A. Yes.

Q. You have explained, therefore, the form which this rebellion takes among the "ignorant;" I want to ask you if you will do the same thing on the other side, and specify what indicates the rebellion amongst the "enlightened;" what did you mean by that?—A. I mean by that that all men of enlightened views are very busily engaged in considering the relations of capital and labor, and are trying to find out a remedy for what they consider to be the wrongs of labor, if you like to put it so. That is to say, an intelligent man goes into an iron works and sees a class of labor employed there which does not strike him as proper, for instance women and children, and he says, "We must change all this. Is there not some mode by which we can improve the condition of things and improve the condition of the laborer? Here we have prices so low that neither capital nor labor can benefit by it; is there any arrangement by which we can bring things back to a better system?" It is for such reasons that they rebel against the system.

Q. You mean intelligent social reformers?—A. Certainly, that class of people, and I include statesmen.

Q. When you speak of "the fundamental principles of social order," do you mean the present social order amongst us, or do you mean the right, normal, and healthy social order?—A. Of course I mean what I hold to be the right and healthy social order. The fundamental principles of social order I understand to be the security of capital, the security of person, and the right of free discussion. Those seem to me to be the fundamental principles of social order—that is the way in which we usually define it—and I say that those principles are violated by some of

these organizations. In the first place, capital is destroyed; personal freedom is also destroyed, because the trades unions will not permit the men to do what they would do of their own free option. Personal freedom is attacked, and capital is attacked, and that, I say, is being at war with the fundamental principles of social order.

Q. When you speak of a rebellion on the part of the enlightened, you think that that is an attempt to introduce changes which would not be antagonistic to those principles of social order?—A. On the contrary, I think that the enlightened people want to make the changes conform to the principles of social order, and I think that the other people are attempting to do the same thing, but by mistaken means, not using wrong means by intention or design. I wish to correct another misstatement in my testimony. I stated that the moulders' association at Troy was not regarded as a pecuniary success. Since I made that statement I have received the report of the Moulders' Union, in which they claim that it is a success, and say that they have been able to increase their capital and pay as large wages as are paid in private establishments, and that they succeeded in establishing the works without the aid of outside capital. I stated formerly, from information which I had, that the capital was furnished by benevolent gentlemen, but in the report which I have in my hand they state that they have had no help of that kind.

By Mr. MATHEWS:

Q. Does the report say that they pay any dividend upon that capital?—A. Yes; it says that they do pay a dividend, and that they pay the same rate of wages as private establishments, and that the concern is regarded as a success.

Q. What dividend do they pay?—A. They commenced with a capital of $20,000, and it is now increased to $50,000, after three years' operation.

Q. They have accumulated, therefore?—A. Yes, they have accumulated.

By the CHAIRMAN:

Q. In regard to the eight hours' labor law, there are two hours thrown upon the hands of the working man if he was previously working ten hours?—A. Yes.

Q. Have you a distinct idea of what you call amusements? because he is to employ those two hours in amusements, I understand?—A. The theory is that he is to employ that time in recreation and improvement.

Q. If you have ever been acquainted, as I am sure you have, with men in the time when their faculties, bodily and mental, are in their highest energy, can you conceive a greater burden to such men than to order them to desist from pursuing an important purpose?—A. I think that it would be an act of tyranny.

Q. And is there any way of pursuing an important purpose in any rank of life except by work?—A. I think that a man who feels that he has a great object to attain never measures his effort by time at all; it is a mere question of physical ability with him how long he can work in order to

accomplish the end at which he aims, and I think that this attempt to bring down the hours of labor to eight by an arbitrary enactment is at war with the fundamental principles not only of social order but of human nature.

Q. Slack men may like to stand in the sun, but the energetic men would feel themselves afflicted by a sore grievance if they were not permitted to pursue an important purpose at their own option?—A. Yes.

By Mr. MERIVALE:

Q. Do you think that in all public offices they ought to work ten hours instead of eight?—A. I am unable to speak of what should be done in public offices.

By Mr. HARRISON:

Q. Do you think that a twelve or a fourteen hours' system would be a movement for the better?—A. No, I do not; I do not know whether eight hours, or ten hours, or twelve hours is the better average condition for the laborer, but my objection is to the system which compels people who are willing to work more than eight hours, and who feel that they could work more than eight hours, to restrict themselves to eight hours; and that is the tyranny which the trades unions would inflict upon labor generally.

By Mr. BOOTH:

Q. Your objection is to any compulsory system?—A. My objection is to any compulsory system. I wish to leave it free between the workman and the employer.

By Mr. HARRISON:

Q. Your opinion has not been given at all on the relative advantages of an eight-hour system or a ten-hour system, provided it is left perfectly free?—A. No; I have given no opinion upon the question which is the best for the normal state of society.

By Mr. MATHEWS:

Q. Is not the rational state of society this—that every man should be left free to work as many or as few hours as his physical strength enables him?—A. Yes.

Q. And any restriction upon that by co-operative societies, or any restriction which compels him to deviate from his natural practice, is an injury to society?—A. Yes; I think that the restriction should only come in among people who are not able to take care of themselves—women and children, and idiots. I mention women as the more helpless members of society as contrasted with men; I think women and children, and those persons whose intellects have been disturbed, are comparatively helpless, and that the law, therefore, must make provision for them.

Q. In regard to the eight-hour system, what would be hard labor for one person with a feeble constitution and feeble powers would be idleness for another man?—A. Yes.

Q. And I think there is an old hymn, familiar in this country, which says "Satan finds some mischief still for idle hands to do?"—A. Yes; we have the same in our country.

By Mr. HARRISON:

Q. What form does the legal compulsion take in the eight-hour law? —A. The legal compulsion would be that on public works, all employment by the state, eight hours would be a day's work, and nobody could work for ten hours; at the end of eight hours the bell rings and the men quit work.

Q. It would be illegal to work longer?—A. Yes; no public officer would be allowed to make the men work for over eight hours, unless at a rate of wages specially agreed upon.

Q. You say that each man should be left free to work as many hours as he thought convenient. In great works, such as iron-works, factories, and so on, it is impossible for men to work different hours, is it not?—A. Yes.

Q. How do you propose to meet that case?—A. The thing has regulated itself in this way: experience has shown about how many hours per day men can work and maintain themselves in good bodily condition, and by long experience the thing has adjusted itself to that condition, and only the men who can work the number of hours which is found to agree perfectly with the bodily condition of the men come there and work; the others quit it.

By Mr. MATHEWS:

Q. In fact, you want men of a higher physical condition to work in iron works?—A. Yes; and the number of hours, from the nature of the case, is adapted to the abilities of the men to labor.

By Mr. HARRISON:

Q. You say that the proper amount of work is the maximum which can be worked by strong, able men without injury to their physical condition?—A. Certainly.

Q. Do you intend to exclude from the consideration their intellectual condition or their education?—A. Yes, I have excluded that in giving you the estimate which I have given, because in the iron works that really does not enter into the question.

Q. Supposing the case of a thousand men who have been in the habit of working 10 hours without injury to their physical condition, but just up to that limit, and who then say, "It is true that it does not injure our physical condition to work 10 hours, but we think that if we work eight hours we shall improve our intellectual condition;" does that seem to you a reasonable basis for them to agree upon in order to fix the hours which the people work?—A. I should think it is perfectly competent for the working men to take that question into consideration in making their arrangements with their employers. On the other hand, the employers may say, "But after working 10 hours you have still sufficient time for

the improvement of your intellect and for recreation;" and that is a question of fact.

Q. If the workmen say they have not sufficient time, what then?—A. If the workmen say they have not then the thing must be adjusted between the two classes? It is like a thousand other questions in society, and they must come to an understanding about it.

Q. There are other elements to be taken into consideration in fixing what should be the hours of work in a large factory, or work, besides the single one you have just mentioned?—A. There are a great many questions to be taken into consideration. The conditions of business, for example, compel us sometimes to cut down the hours of business; sometimes we can only work half-time.

Q. I am speaking of the normal condition, when things are in full work?—A. I think that society always has, in any particular region, the best arrangement of capital and labor that is possible with the knowledge and the means at command of the people who are there. I think that in each place they always arrive at the adjustment which is the best practical adjustment consistent with the amount of knowledge and the amount of resources at command. I find that in one place the adjustment is much more favorable to working men than in another place, and in the same place it is more favorable at one time than at another time. In the United States at present it is an adjustment more favorable to the workmen than it is in England; in England it is more favorable than in France; in France it is more favorable than in Belgium. That is a question of national conscience and of the knowledge and the means at command.

Q. In point of fact the hours of labor are, in the nature of things, variable, and will alter with the progressive civilizations of the community?—A. Beyond doubt, and it would not astonish me to see eight hours as generally recognized as a day's labor as ten hours is now.

By Mr. MATHEWS:

Q. Is it not a fact that when men are getting full wages they dictate their own terms to their masters as to the length of time they will work? For instance, to take the case of iron works, if the master requires the men to work full time they say, "We will not work full time; we find that we can do as well for ourselves in working five days a week as six?" —A. That is my own experience, and that is the experience I think of all iron-masters; but with greater encouragement given to the workmen and with a different arrangement for payment, I think that might be changed. I think that men are just as anxious to earn good wages and to acquire property when they are sufficiently educated as the owners are.

Q. Do not you think that that is better left to the ordinary operation of the relations between employers and employed than to any fixed arrangement that can be adopted?—A. I think that, as a general principle, it is better to leave these questions to the people who have to deal

with them practically, but I am not prepared to say that there may not be grievances so great and persisted in so long, (from habit, perhaps,) that it may be that the legislature should step in and interfere. I think that great wrongs are permitted to go on for some time if left to the voluntary action of the people who have personally to deal with them, and in such cases the legislature should interfere. But I think that if the legislature interferes it should be done with great deliberation and after careful examination.

Q. Only with reference to the interests both of the employer and of the employed?—A. I think that the interests of the community are superior to the interest of any particular employer or employé, and if the legislature find that there is a grievance which employers and employés will not correct, it is the bounden duty of the legislature to correct it.

By Mr. HUGHES:

Q. When you speak of different arrangements between employers and employed, do you think that if the employed were paid by a share in the profits this state of things would pass away?—A. I think that it could be very much ameliorated. In very many branches of business it might be entirely remedied, but there are some branches of business in which I have not seen my way clearly to such an adjustment.

Q. As far as you know, is such a plan applicable to iron works?—A. I think it is.

Q. And coal works?—A. I think it is perfectly applicable to coal works?

Q. I think there has been even in Pennsylvania some attempt of that nature?—A. I have never known any attempt of the kind in Pennsylvania. I have never known any attempt of the kind either in an iron works in America or in a coal works.

By Mr. MATHEWS:

Q. Have you ever known a case of successful co-operation?—A. If I am to believe the statements which are published in regard to the operations of Schultze-Delitzsch, I must say that there are many such in Germany.

By Mr. HUGHES:

Q. Did you ever hear of Briggs & Co., in England?—A. Briggs & Co. I know nothing about. I wish to say that since I testified on the last occasion I have received advices from home of the organization of a very large number of these co-operative associations. It seems to be the case that one of those epidemics which occasionally break out in society has broken out on our side. They are of both kinds, both an association of the capitalist owner with the workmen and an association of workmen by themselves, and both will be tested I think on a very extensive scale in a way that will conform more nearly to English notions than continental experiments can. Continental notions are so different from yours that no experiment there I think could be taken as conclusive with

regard to English industry, but the experiments in the United States I think will be more satisfactory to your view. I anticipate failure in many instances and success in others. Where there is talent, honesty, and care, there will be success; where there is dishonesty, and idleness, and neglect, there will be a failure.

By Mr. BOOTH:

Q. Is the present state of the law in different States such as to permit of the experiment being fairly tried, or would it be necessary that the law should be amended?—A. It will be necessary to amend the law in order to try it upon the system which I think most favorable, but the law is sufficiently broad to permit the arrangements to be carried out which they are now trying, and which I think are not the best, though I think they have got the elements of success.

By Mr. HUGHES:

Q. But I think you will find that in some places the law gives perfect facilities at present, for instance, at Chicago. Within the last six weeks I have had three applications from masters in America, who are thinking of adopting the method, for copies of the rules in use here, and for statements as to what has been done here; and in one instance, certainly the application from Chicago, the letter said that there would be no difficulty whatever as far as the law went. Of course that might be a statement made off-hand?—A. The law in Illinois will permit the organization of joint stock co-operation, and the owners may make such contracts between themselves as they may see fit, and the Northwestern Manufacturing Company of Chicago, as a matter of fact, has been organized upon that basis. It is not organized, however, upon the basis which I consider most favorable to success.

Q. You surely consider that the most favorable system would be that in which the employers and employed both hold capital stock?—A. Yes, I do, and yet I do not think that this one at Chicago is organized upon the basis most favorable to success, and for this reason: the stipulation is that the capital, which is estimated at $300,000, and which is a good deal more than the actual capital that they have, is, under all circumstances, pledged to receive ten per cent.

Q. Ten per cent. may be too high a figure, but you would surely say that some fixed interest must be paid upon capital *pari passu* with wages?—A. Supposing that there is not enough to pay both the men their wages and the capitalist his interest upon the capital, who is to get the money? Society has decided long ago that the workmen shall have it, and I suspect, as the stomach is the foundation of all business, that that decision is a wise one, and therefore any decision which asserts that there shall be a prior right for capital to take ten per cent. will fail. It will fail inevitably, because there must be cases in which the profits will not yield that return to capital as well as paying the wages of the men.

By Mr. MATHEWS:

Q. It will fail, in fact, because there is no provision for recouping the master when such circumstances arise?—A. Yes.

By Mr. HUGHES:

Q. On the average of years, surely businesses of that kind do not lose; they make profits on the average of years, or else nobody would carry them on?—I can only say that I know of many businesses in the United States which have not made money on the average of years, but on the contrary have lost money. The iron business has certainly been the source of immense losses. I have testified here before of the number of iron works that have been sold out, and I doubt whether we could point to ten families in the United States which have been successful in the iron business. I only refer to that as showing the necessity for an arrangement which conforms to experience in regard to business. The workmen have to be fed. The workmen do not know the fact that the business is carried on in order to satisfy that prior lien of theirs upon the property, and they are making war in the United States and here and in France upon the business on which they have a prior lien. The lien may not be large enough in certain cases, but the broad fact that the workman has the prior lien upon every business in every branch of labor is an unmistakable one.

By Mr. MATHEWS:

Q. The difficulty will be to satisfy that prior lien. If the result of the co-operative society did not satisfy that lien sufficiently, and if it did not satisfy the percentage on capital besides, it must fail of itself?—A. Yes.

Q. If the workmen only receive bare subsistence wages until the result of the undertaking is known and the profits are realized, do you think there would be a difficulty in their making a fund out of subsistence wages, and out of any profits that they might be entitled to, which would enable them to provide against such a contingency as an unsuccessful year?—A. Yes, I should have supposed so but for the fact of the extent to which the principle of Schultze-Delitzsch has been adopted in Germany. That is really a most marvellous thing. Those people actually abated 20 and in some cases 40 per cent. to get such a fund, and I am satisfied that with the temper of our people in the United States I could go to my leading workmen and say, "We shall go on paying you your present rate of wages, but I ask you to leave behind so much as will form a fund for that purpose," and they would willingly consent to do so.

By Mr. HUGHES:

Q. Did you ever hear of such things as bare subsistence wages in the United States?—A. I have heard of it, because we have had such things as labor going down to a very low point.

Q. I remember, in 1848 and 1849, when many of the associations in Paris were going on for months, the men drawing only 10 francs a week on account of their wages. You never heard of such wages as those in

America?—A. I can remember when wages have been down in America, in times of depression, to as low as 50 cents per day, which would be about 2s. per day in English money; that is as low as I have ever known anything got in America, and that was very exceptional indeed. There is one other thing which I wish to correct. I saw some comments in the London Times which seemed to look to testimony on my part that certain puddlers had murdered other puddlers coming to Pittsburg. Now I was very careful to state that I spoke of the murders only as evidence of the demoralization of a community where a strike had been going on for months, that I was merely informed that these murders had taken place, and that I did not know by whom, so that any inference from my testimony that one set of workmen had murdered another set was quite unfounded.

By Mr. HARRISON:

Q. That was clearly so put in your evidence, was it not?—A. I think it was.

By the EARL OF LICHFIELD:

Q. You said with regard to the employment of children in iron works in America that they were not employed before the age of 13 and 14.—Does that apply to other trades in America?—A. As a general rule it is a rare thing to see a young child not 13 or 14 in any physical employment, very rare indeed.

Q. Are those children up to the age of 13 or 14 generally at school? A. Yes.

Q. And have you any provision, generally speaking, in the iron works and in other trades for the education of those children, continuing after the age when you say they begin to be employed in the iron works?—A. No, there is no provision, except that in the large cities there are night-schools, and in New York, as I testified, the Cooper Institute affords the very largest possible instruction to mechanics. That is a private endowment.

By Mr. MATHEWS:

Q. I think you gave us some particulars of the Cooper Institute?—A. I did mention some particulars in reference to that. I wish to correct my testimony on another point. A Welsh ironmaster tells me that I am mistaken in my testimony as to women lifting those heavy bars of iron of which I spoke, two inches thick, five feet long, eight inches wide. I say that I actually saw one of those lifted, but this gentleman informs me that these heavy bars are lifted by men who are sent to do this heavy work. I merely saw the women making the piles, and I inferred that they put the tops and bottoms on because they were the only persons there, but I am informed that it is not so.

Q. So that the employment of women in iron works is not so heavy as you thought it was?—A. I still repeat my testimony that it is a great

deal heavier work than I have ever seen women do before; but I correct that particular statement as to the bars.

By Sir D. GOOCH:

Q. Is there any compulsion in America in regard to education?—A. No compulsion in any place, except perhaps recently in Massachusetts. I have heard recently that a law for compulsory education has been passed there, but I am not sure of it; but in the other States there is no compulsion.

By Mr. BOOTH:

Q. Have you read the statement of the "Times" correspondent to that effect, that there is compulsory education?—A. I have not read the statement, but I know that there is no compulsory education in New York or New Jersey. It is just possible that there is in Massachusetts.

By the EARL of Lichfield:

Q. But education is provided out of the rates?—A. Education is paid for by the public and assessed for by rates on the district, and most of the States have school funds out of which they make a distribution annually to each district.

Q. And the children up to the age of 13 or 14 avail themselves very generally of that opportunity of education?—A. Very generally.

Q. I think you say that a great number of young persons after the age of 13 and 14 avail themselves of night-schools?—A. In the cities.

Q. And do not you attribute that very much to the fact of their having been able to obtain tolerable education before beginning their employment?—A. No; I am sorry to state that the opposite is the case; that the ones that go to the night-schools are usually those that have had no opportunity of education in the day-schools. Those who go to the night-schools are, in New York, mostly foreigners who want to learn the language, or mechanics who have not received the ordinary elements of education. But in the case of the Cooper Institute, those who attend the classes are persons who have received some education before.

Q. Is that an industrial education? Are men instructed in their trades? —A. No; they are instructed in that kind of knowledge which is necessary for them to conduct their trades intelligently; for instance, the machinist is taught drawing, and we teach chemistry and natural philosophy there. The learning there is all book learning, but it is with reference to the business which the pupil is engaged in.

Q. Is not that statement of yours somewhat remarkable, that those who have had the advantage of an education up to 13 or 14 are not desirous of continuing their education afterwards?—A. No, it is not remarkable, for the reason that these night-schools do not teach anything more than what they have already learned in the day-schools. But in New York last winter a higher grade of school was opened, the first one which had ever been opened there, and it was filled to repletion by those

who had been to the day-schools and had learned a certain amount and wished to continue their education.

Q. You have no night-schools where they have an opportunity of continuing their education from the point at which they have arrived at the age of 13 or 14?—A. Except the Cooper Institute we had none until the one that I have just referred to was opened.

Q. Do you not think that if they had the opportunity of continuing their education from the point arrived at, at the age of 13 or 14, they would avail themselves of it?—A. Experience makes me certain of that, because everything of that sort that exists has been used to the fullest possible degree.

Q. Do you find a very marked difference in the intelligence of those who come from this country and Germany and Ireland and other places, when they come to be employed in your works, as compared with those who were educated in your own country?—A. I think that that question would have to be answered with reference to specific occupations. I think that the experience will be different in different operations. In iron works, certainly, we find that the Englishmen are the best workmen, better than those whom we train up; that is to say, as a general proposition, I think the English workmen are better than those we train up in the iron works. And yet there are some branches of our business in which our own people are better; it is a question very much of adaptability to particular kinds of employment. I think that in guide-rolling our Americans are more active and better rollers than the English, but when it comes to puddling the heavy bars the English are better workmen.

By Mr. MATHEWS:

Q. Where you want physical force combined with skill?—A. Where we want physical force combined with skill we get Englishmen.

Q. We can infer from that that they are stronger men that we rear up here than you do in America?—I think they are.

By Mr. HUGHES:

Q. I think your strongest men go west?—A. I think everybody must remark the superior physical development of the Englishmen over the Americans; that you here are a better physically-developed race than we are.

Q. Has that held within the last few years, do you think?—A. It has always appeared to me so. I was struck with it 20 years ago, and I am struck with it now. I consider the English race, as I see it, the best physical race in the world.

By Mr. HARRISON:

Q. In spite of unionism?—A. In spite of unionism; in fact, I do not think that unionism would be possible anywhere else than in England and America, and so far it is a healthy sign.

The witness withdrew.

APPENDIX I.

POOR RATES AND PAUPERISM.

Return (in part) to an order of the honorable the House of Commons, dated 9th July, 1867, for return of "Comparative statement of the number of paupers of all classes (except lunatic paupers in asylums and vagrants) in receipt of relief on the last day of each week in the months of April, May, June, July, August, September, October, November, and December, 1866 and 1867, respectively; also for the months of January, February, and March, 1867 and 1868, respectively;" "statement of the number of paupers, distinguishing the number of adult able-bodied paupers relieved on the 1st day of July, 1867;" "similar statement for the 1st day of January, 1868;" "statement of the amount expended for in-maintenance and out-relief only, for the half year ended at Michaelmas, 1867;" "similar statement for the half year ended at Lady day, 1868;" "statement of the amount of poor-rates levied and expended during the year ended at Lady day, 1867;" "and of the number of insane paupers chargeable to the poor-rates on the 1st day of January, 1868."

FREDERICK PURDY,
Principal of the Statistical Department.

POOR-LAW BOARD,
Whitehall, July 9, 1867.

QUARTERLY STATEMENT AS TO PAUPERISM, MICHAELMAS, 1867.

(Paupers in lunatic asylums and vagrants not included.)

The present return completes the monthly series for the quarter ended at Michaelmas, 1867. The four following tables are given in continuation of those prefixed to the monthly publication for June last.

The tables are—

1. England and Wales; the pauperism in the consecutive weeks of the quarter.
2. (England and Wales;) the comparative pauperism of the quarter.
3. North Midland, Northwestern, and York divisions; the comparative pauperism of the quarter.
4. The Metropolis; the comparative pauperism of the quarter.

I. In the first table each week is compared with the one immediately preceding it; 884,829 were the numbers relieved in the last week of June, (midsummer;) but in the fourth week of September (Michaelmas) the numbers were 872,620, which is a decrease of 12,209, or 1.4 per cent. less at Michaelmas than midsummer.

TABLE I.—*England and Wales—Consecutive statement.*

Periods.	Number of paupers on the last day of each week.	Difference between the proximate weeks.	
		Increase.	Decrease.
1867.			
June:			
Fourth week	884,829	....	....
July:			
First week	878,879	....	5,950
Second week	876,670	....	2,209
Third week	877,531	861	....
Fourth week	876,998	....	533
Fifth week	877,020	22	....
August:			
First week	875,767	....	1,253
Second week	874,211	....	1,556
Third week	870,978	....	3,233
Fourth week	871,572	594	....
September:			
First week	868,415	....	3,157
Second week	869,067	652	....
Third week	869,992	925	....
Fourth week	872,620	2,628	....

II. The next table exhibits the comparative pauperism during the Michaelmas quarter of 1865, 1866, and 1867.

The paupers in receipt of relief on the last day of the last week of September were—

In 1865	835,005
In 1866	842,860
In 1867	872,620

The paupers in 1867, as compared with those in 1866, have increased 29,760, or 3.5 per cent.; but compared with 1865 the increase was 37,615, or 4.5 per cent.

TABLE II.—*England and Wales—Comparative statement.*

Periods.	Paupers in receipt of relief on the last day of each week.			Difference per cent in the numbers in column (c) compared with each of the two preceding years.			
	1865.	1866.	1867.	Last year but one. (a)		Last year. (b)	
	(a)	(b)	(c)	*Increase.*	*Decrease.*	*Increase.*	*Decrease.*
June:							
Fourth week	853, 073	841, 489	884, 829	....	....	....	....
July:							
First week	846, 082	835, 507	878, 879	3.9	....	5.2	....
Second week	842, 469	833, 977	876, 670	4.1	....	5.1	....
Third week	841, 567	833, 738	877, 531	4.3	....	5.3	....
Fourth week	840, 131	833, 874	876, 998	4.4	....	5.2	....
Fifth week	837, 991	836, 486	877, 020	4.7	....	4.8	....
August:							
First week	836, 580	839, 493	875, 767	4.7	....	4.3	....
Second week	834, 758	840, 146	874, 211	4.7	....	4.1	....
Third week	833, 758	839, 278	870, 978	4.5	....	3.8	....
Fourth week	833, 042	840, 388	871, 572	4.6	....	3.7	....
September:							
First week	832, 293	840, 894	868, 415	4.3	....	3.3	....
Second week	832, 443	840, 931	869, 067	4.4	....	3.3	....
Third week	832, 705	843, 452	869, 992	4.5	....	3.1	....
Fourth week	835, 005	842, 860	872, 620	4.5	....	3.5	....

III. The third table comprises the three divisions of England and Wales, in which the principal manufactures are carried on. Taking the returns of paupers relieved on the last day of the last week of September the numbers were—

In 1865.. 206, 076
In 1866.. 196, 747
In 1867.. 202, 853

The increase in 1867, compared with 1866, was 6,106, or 3.1 per cent., but in comparison with 1865 there was a decrease of 3,223, or 1.6 per cent.

TABLE III.—*North Midland, Northwestern, and York divisions—Comparative statement.*

Periods.	Paupers in receipt of relief on the last day of each week.			Difference per cent. in the numbers in column (c) compared with each of the two preceding years.			
	1865.	1866.	1867.	Last year but one. (a)		Last year. (b)	
	(a)	(b)	(c)	*Increase.*	*Decrease.*	*Increase.*	*Decrease.*
June:							
Fourth week	217, 276	198, 360	206, 084	....	....	....	....
July:							
First week	213, 819	197, 207	204, 569	....	4.3	3.8	....
Second week	211, 013	196, 246	203, 648	....	3.5	3.8	....
Third week	209, 598	195, 887	203, 855	....	2.7	4.1	....
Fourth week	208, 517	195, 841	203, 494	....	2.4	3.9	....
Fifth week	207, 513	195, 753	203, 427	....	2.0	3.9	....
August:							
First week	207, 346	195, 872	203, 011	....	2.1	3.6	....
Second week	206, 864	195, 733	202, 701	....	2.0	3.6	....
Third week	206, 618	195, 508	202, 195	....	2.1	3.4	....
Fourth week	206, 369	196, 407	202, 081	....	2.1	2.9	....
September:							
First week	205, 954	195, 989	201, 956	....	1.9	3.0	....
Second week	206, 299	196, 053	201, 555	....	2.3	2.8	....
Third week	205, 994	196, 424	202, 498	....	1.7	3.1	....
Fourth week	206, 076	196, 747	202, 583	....	1.6	3.1	....

IV. According to the last returns for the month of September in the three years last past, the number in the metropolis was—

In 1865 .... 91, 022
In 1866 .... 105, 827
In 1867 .... 117, 849

In 1867 the increase in the paupers as compared with those in 1866 was 12,022, or 11.4 per cent.; and on a comparison with 1865, there was an increase of 26,827, or 29.5 per cent.

TABLE IV.—*The metropolis—Comparative statement.*

Periods.	Paupers in receipt of relief on the last day of each week.			Difference per cent. in the numbers in column (c) compared with each of the two preceding years.			
	1865.	1866.	1867.	Last year but one. (a)		Last year. (b)	
	(a)	(b)	(c)	*Increase.*	*Decrease.*	*Increase.*	*Decrease.*
June:							
Fourth week	90,722	98,308	118,982	....	....	....	....
July:							
First week	90,004	98,455	117,738	30.8	....	19.6	....
Second week	89,937	98,778	117,880	31.0	....	19.3	....
Third week	90,109	99,400	118,206	31.2	....	18.9	....
Fourth week	90,218	100,488	118,299	31.1	....	17.7	....
Fifth week	90,232	102,960	118,046	30.8	....	14.7	....
August:							
First week	90,686	105,197	118,347	30.5	....	12.5	....
Second week	91,190	106,100	117,547	28.9	....	10.8	....
Third week	91,317	106,499	117,653	28.8	....	10.5	....
Fourth week	90,963	106,623	117,523	29.2	....	10.2	....
September:							
First week	91,058	106,664	116,983	28.5	....	9.7	....
Second week	90,588	105,624	116,457	28.6	....	10.3	....
Third week	90,696	106,012	116,417	28.4	....	9.8	....
Fourth week	91,022	105,827	117,849	29.5	....	11.4	....

FREDERICK PURDY,
Principal of the Statistical Department.

POOR-LAW BOARD, WHITEHALL, *November* 14, 1867.

MEMORANDUM.

As to the arrangement of the weekly returns of pauperism.

The returns of the number of paupers relieved on the last day of each week do not include the "lunatic paupers in asylums and licensed houses," nor the number of vagrants relieved. These classes form only a small portion of the entire pauperism of the country. According to the latest returns, (January 1, 1866,) the number contained in the two classes was 3 per cent. of the total pauperism.

The pauper lunatics in asylums are not generally subject to variations in number to the same degree as the other classes of paupers; and the number of vagrants relieved by the unions throughout the country has become too small to need a return so frequently as once a week. These considerations led to the exclusion of the two classes.

There are at present 14,886[1] parishes, inclusive of the Scilly islands, in England and Wales, maintaining, or liable to maintain, their own poor; returns of pauperism are received weekly in respect of 14,695 of that number; 191 parishes, incorporated under Gilbert's act, or still under

[1] Many places, not heretofore liable to maintain their own poor, are becoming parishes under the operation of the extra parochial places act; to what extent this will ultimately increase the number of parishes in England and Wales cannot at present be stated.

the provisions of the 43d Elizabeth, made no return of the number of paupers which they relieve.

The returns are arranged under eleven divisions. The union counties which fall under each are shown in the following view:

I. The Metropolis.
1. Middlesex, (part of.)
2. Surrey, (part of.)
3. Kent, (part of.)

II. Southeastern.
1. Middlesex, (part of.)
2. Surrey, (part of.)
3. Kent, (part of.)
4. Sussex.
5. Southampton.
6. Berks.

III. South Midland.
7. Hertford.
8. Buckingham.
9. Oxford.
10. Northampton.
11. Huntingdon.
12. Bedford.
13. Cambridge.

IV. Eastern.
14. Essex.
15. Suffolk.
16. Norfolk.

V. Southwestern.
17. Wilts.
18. Dorset.
19. Devon.
20. Cornwall.
21. Somerset.

VI. West Midland.
22. Gloucester.
23. Hereford.
24. Salop.
25. Stafford.
26. Worcester.
27. Warwick.

VII. North Midland.
28. Leicester.
29. Rutland.
30. Lincoln.
31. Nottingham.
32. Derby.

VIII. Northwestern.
33. Chester.
34. Lancaster.

IX. York.
35. West Riding.
36. East Riding.
37. North Riding.

X. Northern.
38. Durham.
39. Northumberland.
40. Cumberland.
41. Westmoreland.

XI. Welsh.
42. Monmouth.
43. South Wales.
44. North Wales.

The following is a tabular statement of the number of unions and parishes, and the area and population ascribable to each division; but so far only as represented by the weekly returns:

Divisions.	Number of unions, &c.	Number of parishes.	Area in statute acres.	Population in 1866.
1. The Metropolis	39	190	77,944	2,802,367
2. Southeastern	97	1,426	3,922,839	1,805,534
3. South Midland	64	1,447	3,198,570	1,295,138
4. Eastern	56	1,644	3,209,894	1,142,230
5. Southwestern	80	1,792	4,989,180	1,833,074
6. West Midland	82	1,667	3,851,187	2,434,614
7. North Midland	45	1,750	3,533,919	1,987,972
8. Northwestern	40	923	1,911,616	2,983,467
9. York	60	1,464	3,411,825	1,880,233
10. Northern	39	1,173	3,492,322	1,151,338
11. Welsh	53	1,219	5,210,747	1,311,109
England and Wales, (so far as returned)	655	14,695	36,810,543	19,886,104

The absolute as well as the proportional numbers of the adult population, under six industrial classes, are shown in the subjoined table for each division:

Divisions.	Persons aged 20 years and upwards.						
	Classes.						
	1.	2.	3.	4.	5.	6.	
	Professional.	Domestic.	Commercial.	Agricultural.	Industrial.	Indefinite and non-productive.	Total.
1. The Metropolis	95, 925	665, 168	135, 846	25, 260	584, 787	110, 944	1, 617, 930
2. Southeastern	90, 086	413, 256	37, 907	187, 250	227, 043	65, 687	1, 021. 229
3. South Midland	22, 571	243, 351	16, 571	169, 850	202, 169	40, 852	695, 364
4. Eastern	21, 245	239, 981	19, 883	164, 577	144, 230	29, 082	618, 998
5. Southwestern	46, 662	364, 951	29, 626	215, 503	285, 528	57, 484	999, 714
6. West Midland	35, 203	487, 112	44, 030	186, 661	487, 365	76, 832	1, 317, 203
7. North Midland	16, 930	244, 257	16, 311	150, 417	241, 153	29, 984	699, 052
8. Northwestern	36, 290	549, 109	101, 295	124, 838	715, 542	75, 757	1, 062, 831
9. York	24, 804	393, 346	38, 661	143, 508	446, 765	42, 451	1, 089, 535
10. Northern	13, 282	240. 865	35, 853	82, 488	207, 784	32, 160	612, 442
11. Welsh	15, 941	262, 649	24, 640	155, 151	204, 412	46, 467	709, 260
England and Wales	418, 899	4, 104, 045	500, 623	1, 605, 503	3, 746, 788	607, 700	10, 983, 558

Divisions.	To every 100 persons, aged 20 years and upwards, of all occupations, the proportional number of each class.						
	Classes.						
	1.	2.	3.	4.	5.	6.	
	Professional.	Domestic.	Commercial.	Agricultural.	Industrial.	Indefinite and non-productive.	Total.
1. The Metropolis	5. 9	41. 1	8. 4	1. 6	36. 1	6. 9	100. 0
2. Southeast ·rn	8. 8	40. 6	3. 7	18. 3	22. 2	6. 4	100. 0
3. South Midland	3. 2	35. 0	2. 4	24. 4	29. 1	5. 9	100. 0
4. Eastern	3. 4	38. 8	3. 2	26. 6	22. 3	4. 7	100. 0
5. Southwestern	5. 7	36. 4	3. 0	21. 6	28. 5	5. 8	100. 0
6. West Midland	2. 7	37. 0	3. 3	14. 2	37. 0	5. 8	100. 0
7 North Midland	2. 4	35. 0	2. 3	21. 5	34. 5	4. 3	100. 0
8. Northwestern	2. 3	34. 3	6. 3	7. 8	44. 6	4. 7	100. 0
York	2. 3	36. 1	3. 5	13. 2	41. 0	3. 9	100. 0
10 Northern	2. 2	39. 2	5. 9	13. 5	33. 9	5. 3	100. 0
Welsh	2. 2	37. 0	3. 5	21. 9	28. 8	4. 6	100. 0
England and Wales	3. 8	37. 4	4. 6	14. 6	34. 1	5. 5	100. 0

The numbers in the last table represent *complete* divisions; as it was impossible, from the manner in which the census of occupations is compiled, to make the same adjustment in respect of the unreturned parishes as that effected for the first table. **F. P.**

Comparative statement of the number of paupers (except lunatic paupers in asylums, and vagrants) in receipt of relief on the last day of the first week of September, 1866 *and* 1867.

Divisions.	Year.	Number of paupers relieved.			Difference between the corresponding weeks.		Difference per cent.	
		In-door.	Out-door.	Total.	Increase.	Decrease.	Increase.	Decrease.
I. The Metropolis....	1866	29,758	76,906	106,664	10,319	....	9.7	....
	1867	32,054	84,929	116,983				
II. Southeastern......	1866	14,099	71,006	85,105	744	....	0.9	....
	1867	14,421	71,428	85,849				
III. South Midland	1866	7,511	59,882	67,393	1,314	....	1.9	....
	1867	7,647	61,060	68,707				
IV. Eastern	1866	7,827	60,299	68,126	394	....	0.6	....
	1867	8,399	60,121	68,520				
V. Southwestern	1866	10,149	90,696	100,845	1,953	....	1.9	....
	1867	10,831	91,967	102,798				
VI. West Midland.....	1866	13,048	83,582	96,630	1,177	....	1.2	....
	1867	14,132	83,675	97,807				
VII. North Midland	1866	5,579	44,317	49,896	494	....	1.0	....
	1867	5,802	44,588	50,390				
VIII Northwestern	1866	17,660	69,460	87,120	3,517	....	4.0	....
	1867	19,172	71,465	90,637				
IX. York	1866	7,159	51,814	58,973	1,956	....	3.3	....
	1867	7,755	53,174	60,929				
X. Northern	1866	4,761	39,835	44,596	2,778	....	6.2	....
	1867	5,062	42,312	47,374				
XI. Welsh	1866	3,931	71,615	75,546	2,875	....	3.8	....
	1867	4,414	74,007	78,421				
England and Wales, (so far as returned.)	1866	121,482	719,412	840,894	27,521	....	3.3	....
	1867	129,689	738,726	868,415				

***Comparative statement of the number of paupers (except lunatic paupers in asylums, and vagrants) in receipt of relief on the last day of the second week of September,* 1866 *and* 1867.**

Divisions.	Year.	Number of paupers relieved.			Difference between the corresponding weeks.		Difference per cent.	
		In-door.	Out-door.	Total.	Increase.	Decrease.	Increase.	Decrease.
I. The Metropolis....	1866	29,877	75,747	105,624	10,833	....	10.3	....
	1867	32,057	84,400	116,457				
II. Southeastern......	1866	13,886	70,854	84,740	1,401	....	1.7	....
	1867	14,216	71,925	86,141				
III. South Midland	1866	7,566	59,960	67,526	1,225	....	1.8	....
	1867	7,705	61,046	68,751				
IV. Eastern	1866	7,954	60,392	68,346	375	....	0.5	....
	1867	8,484	60,237	68,721				
V. Southwestern	1866	10,284	91,048	101,332	1,865	....	1.8	....
	1867	10,910	92,287	103,197				
VI. West Midland.....	1866	13,127	83,697	96,824	1,142	....	1.2	....
	1867	14,095	83,871	97,966				
VII. North Midland	1866	5,619	44,116	49,735	599	....	1.2	....
	1867	5,842	44,492	50,334				
VIII. Northwestern	1866	17,883	69,445	87,328	2,994	....	3.4	....
	1867	19,122	71,200	90,332				
IX. York	1866	7,178	51,812	58,990	1,909	....	3.2	....
	1867	7,758	53,141	60,899				
X. Northern	1866	4,787	40,053	44,840	2,633	....	5.9	....
	1867	5,112	42,361	47,473				
XI. Welsh	1866	3,915	71,731	75,646	3,160	....	4.2	....
	1867	4,405	74,401	78,806				
England and Wales, (so far as returned.)	1866	122,076	718,855	840,931	28,136	....	3.3	....
	1867	129,706	739,361	869,067				

Comparative statement of the number of paupers (except lunatic paupers in asylums, and vagrants) in receipt of relief on the last day of the third week of September, 1866 *and* 1867.

Divisions.	Year.	Number of paupers relieved.			Difference between the corresponding weeks.		Difference per cent.	
		In-door.	Out-door.	Total.	Increase.	Decrease.	Increase.	Decrease.
I. The Metropolis....	1866	30, 105	75, 907	106, 012	10, 405	....	9.8	....
	1867	32, 313	84, 104	116, 417				
II. Southeastern......	1866	13, 921	70, 953	84, 874	1, 084	....	1.3	....
	1867	14, 326	71, 632	85, 958				
III. South Midland....	1866	7, 718	60, 350	68, 068	1, 243	....	1.8	....
	1867	7, 766	61, 545	69, 311				
IV. Eastern............	1866	8, 021	60, 816	68, 837	119	....	0.2	....
	1867	8, 623	60, 333	68, 956				
V. Southwestern	1866	10, 427	91, 280	101, 707	1, 496	....	1.5	....
	1867	10, 961	92, 242	103, 203				
VI. West Midland.....	1866	13, 942	83, 590	96, 762	1, 294	....	1.3	....
	1867	14, 135	83, 921	98, 056				
VII. North Midland	1866	5, 663	44, 072	49, 735	700	....	1.4	....
	1867	5, 879	44, 556	50, 435				
VIII. Northwestern	1866	18, 026	69, 427	87 453	3, 511	....	4.0	....
	1867	19, 281	71, 683	90, 964				
IX. York	1866	7, 186	52, 050	59, 236	1, 863	....	3.1	....
	1867	7, 741	53, 358	61, 099				
X. Northern	1866	4, 742	39, 916	44, 658	2, 686	....	6.0	....
	1867	5, 096	42, 248	47, 344				
XI. Welsh	1866	3, 956	72, 154	76, 110	2, 139	....	....	....
	1867	4, 413	73, 836	78, 249				
England and Wales, (so far as returned.)	1866	123, 007	720, 445	843, 452	26, 540	....	3.1	....
	1867	130, 534	739, 458	869, 992				

Comparative statement of the number of paupers (except lunatic paupers in asylums, and vagrants) in receipt of relief on the last day of the fourth week of September, 1866 *and* 1867.

Divisions.	Year.	Number of paupers relieved.			Difference between the corresponding weeks.		Difference per cent.	
		In-door.	Out-door.	Total.	Increase.	Decrease.	Increase.	Decrease.
I. The Metropolis....	1866	30, 301	75, 596	105, 827	12, 022	....	11. 4	....
	1867	32, 637	85, 212	117, 749				
II. Southeastern......	1866	13, 945	70, 573	84, 518	2, 283	....	2. 7	....
	1867	14, 516	72, 285	86, 801				
III. South Midland	1866	7, 799	59, 923	67, 722	1, 708	....	2. 5	....
	1867	7, 852	61, 578	69, 430				
IV. Eastern	1866	8, 085	60, 047	68, 132	1, 100	....	1. 6	....
	1867	8, 717	60, 515	69, 232				
V. Southwestern	1866	10, 548	91, 545	102, 093	1, 420	....	1. 4	....
	1867	11, 064	92, 449	103, 513				
VI. West Midland	1866	13, 293	83, 382	96, 675	1, 033	....	1. 1	....
	1867	14, 196	83, 512	97, 708				
VII. North Midland	1866	5, 714	43, 957	49, 672	914	....	1. 8	....
	1867	5, 884	44, 702	50, 586				
VIII. Northwestern	1866	18, 176	69, 512	87, 688	3, 238	....	3. 7	....
	1867	19, 479	71, 447	90, 926				
IX. York	1866	7, 248	52, 139	59, 387	1, 954	....	3. 3	....
	1867	7, 771	53, 570	61, 341				
X. Northern	1866	4, 759	40, 131	44, 890	2, 373	....	5. 3	....
	1867	5, 107	42, 156	47, 263				
XI. Welsh	1866	3, 997	72, 259	76, 256	1, 715	....	2. 2	....
	1867	4, 398	73, 573	77, 971				
England and Wales, (so far as returned.)	1866	123, 865	718, 995	842, 860	29, 760	....	3. 5	....
	1867	131, 621	740, 999	872, 620				

APPENDIX K.

EDUCATION.

Returns for the years 1859–'66 of—

1. The number of grants made in each year for building, enlarging, or improving elementary day schools in England and Wales, in Scotland, and in Great Britain, with the total amount of such grants.

2. The number of schools inspected, distinguishing schools from departments of schools.

3. The average number of scholars attending the schools inspected and the number of scholars present on the day of inspection.

4. The number of certificated teachers acting in the schools inspected.

(Presented to both houses of Parliament by command of her Majesty.)

I.—ENGLAND AND WALES.

Year.	Years ending 31st December. Grants for building, enlarging, and improving schools. No. of grants.	Total amount. £	s.	d.	Years ending 31st August. Number of schools inspected. Institutions.	Departments. Boys.	Girls.	Infants.	Mixed.	Total.	Number of scholars. In average attendance.	Present at inspection.	Number of certificated teachers acting in schools inspected.
1859..	434	124, 820	9	10	5, 531	2, 024	1, 958	1, 280	3, 021	8, 283	674, 602	757, 072	5, 225
1860..	388	111, 274	14	2	6, 012	2, 162	2, 048	1, 414	3, 388	9, 012	751, 325	830, 971	6, 342
1861..	310	92, 293	4	0	6, 259	2, 162	2, 014	1, 537	3, 604	9, 317	773, 831	879, 884	6, 738
1862..	223	58, 389	17	0	6, 113	2, 090	1, 924	1, 526	3, 533	9, 073	790, 056	889, 994	7, 465
1863..	163	34, 425	1	11	6, 188	2, 430	2, 120	1, 511	3, 171	9, 232	825, 691	911 287	7, 875
1864..	129	25, 329	12	6	6, 428	2, 039	1, 750	1, 448	4, 028	9, 265	828, 946	955, 179	8, 587
1865..	101	17, 759	13	0	6, 815	2, 211	1, 787	1, 605	4, 336	9, 939	860, 370	1, 042, 766	9, 429
1866..	120	23, 250	2	5	7, 081	2, 243	1, 841	1, 651	4, 550	10, 285	871, 309	1, 086, 812	9, 905

II.—SCOTLAND.

1859..	43	9, 378	16	7	1, 055	81	176	58	957	1, 272	126, 799	123, 049	997
1860..	28	5, 828	12	6	1, 260	98	166	63	1, 064	1, 391	132, 909	131, 961	1, 170
1861..	31	7, 213	11	4	1, 446	119	246	83	1, 135	1, 583	146, 104	148, 806	1, 311
1862..	28	5, 598	9	9	1, 456	89	193	71	1, 231	1, 584	149, 573	150, 316	1, [illegible]
1863..	12	2, 256	17	6	1, 551	119	237	98	1, 260	1, 714	166, 494	165, 145	1, [illegible]
1864..	7	976	4	4	1, 463	192	258	102	1, 111	1, 663	153, 539	155, 178	1, [illegible]
1865..	10	1, 123	3	0	1, 623	71	101	102	1, 522	1, 796	161, 529	171, 504	1, 837
1866..	10	972	0	6	1, 672	89	126	100	1, 530	1, 845	167, 874	178, 017	1, 9[illegible]

Returns for the years 1859–'66—Continued.

III.—GREAT BRITAIN.

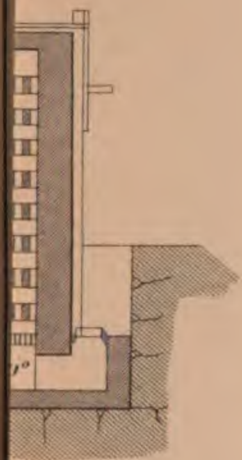
Year.	Years ending 31st December.				Years ending 31st August.								
	Grants for building, enlarging, and improving schools.				Number of schools inspected.						Number of scholars.		Number of certificated teachers acting in schools inspected.
	No. of grants.	Total amount.			Institutions.	Departments.							
		£	s.	d.		Boys.	Girls.	Infants.	Mixed.	Total.	In average attendance.	Present at inspection.	
1859..	477	134, 199	6	5	6, 586	2, 105	2, 134	1, 338	3, 978	9, 555	801, 401	880, 131	6, 222
1860..	416	117, 103	6	8	7, 272	2, 260	2, 214	1, 477	4, 452	10, 403	884, 234	962, 932	7, 512
1861..	341	99, 506	15	4	7, 705	2, 281	2, 260	1, 620	4, 739	10, 900	919, 935	1, 028, 690	8, 069
1862..	251	63, 988	6	9	7, 569	2, 179	3, 117	1, 597	4, 764	10, 657	948, 629	1, 040, 310	8, 899
1863..	175	36, 681	19	5	7, 739	2, 549	2, 357	1, 609	4, 431	10, 946	992, 185	1, 076, 432	9, 481
1864..	136	26, 305	16	10	7, 891	2, 231	2, 008	1, 550	5, 139	10, 928	982, 485	1, 110, 357	10, 193
1865..	111	18, 882	16	0	8, 438	2, 282	1, 888	1, 707	5, 858	11, 735	1, 021, 899	1, 214, 270	11, 266
1866..	130	24, 222	2	11	8, 753	2, 332	1, 967	1, 751	6, 080	12, 130	1, 039, 183	1, 264, 829	11, 871

Plate I.

urnace

ens

tor



ture

the

to

is

C.

unkfors, May 1866.

undin.

Bowen & C° lith. Philad^a

PARIS UNIVERSAL EXPOSITION, 1867.

REPORTS OF THE UNITED STATES COMMISSIONERS.

REPORT

UPON THE

PRECIOUS METALS:

BEING

STATISTICAL NOTICES

OF THE

PRINCIPAL GOLD AND SILVER PRODUCING REGIONS OF THE WORLD REPRESENTED AT THE PARIS UNIVERSAL EXPOSITION.

BY

WILLIAM P. BLAKE,

COMMISSIONER FROM THE STATE OF CALIFORNIA.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1869.

REPORT ON THE PRECIOUS METALS.

INTRODUCTION.

This report was prepared at the request of Committee No. 6 of the United States Commission, and was submitted in December, 1867.

The short time allowed for the work (from September to December) did not permit of an attempt to describe and discuss the various methods of extracting these metals from their ores, and as most of the principal gold and silver producing regions of the globe were represented at the Exposition by specimens, maps, and statistics, with the object of presenting a view of the nature and the extent of the resources of each country in the precious metals, it appeared proper that the report should compass, as far as possible, the object of the various exhibits. Accordingly, brief descriptive and statistical notices of most of the known gold and silver producing regions of the world have been given, with the addition, in some cases, of notices of regions not represented at the Exposition, in order to make the report more complete, and to give as nearly as possible the statistics of the annual production of gold and silver.

Statistics of the production in Europe and other countries were obtained as far as possible up to the year 1867; but the delay in printing the report of the United States commissioners has enabled the author to present some later returns, especially from the United States, and to make some additions to the report, including a chapter upon international coinage.

If this delay in the publication of the report had been foreseen, the plan of the work would have been somewhat different, and arrangements would have been made to obtain publications and statistics, especially from South America, Russia, and Europe, so as to state the amount of production down to the year 1868, or later.

The returns so far received from the Pacific coast indicate that there has been a very considerable falling off in the production for the year 1868, not only in gold but in the silver of Nevada. It also appears probable that the statement of the total gold and silver production of the country for 1867, given on page 212, although considerably less than other published estimates, is yet too high by from \$2,000,000 to \$2,500,000, or about the amount which is credited, by estimate, to Utah and unenumerated sources. The total value of the yield for 1867 was probably from \$69,000,000 to \$70,000,000, and for 1868 from \$65,000,000 to \$66,000,000.

It is impossible, in a work of this kind—the greater part of which was printed in 1868—to present statistics as late and fresh as those given from time to time by the enterprising journalists of California, who make

the collection of accurate statistics and late information from the mining districts a specialty. The progress of discovery in our unexplored mineral regions is so rapid that new and important information is almost daily received.

The author is specially indebted to "Carmany's Commercial Herald and Market Review," and to the quarterly reports in the "Alta California," for statistics of the production in the Pacific States and Territories, and he also acknowledges his obligations to several of the foreign commissioners and others at the Exposition for valuable statistical information.

Respectfully submitted:

WILLIAM P. BLAKE.

JANUARY, 1869.

CONTENTS.

GOLD.

SILVER.

CHAPTER IX.

CONSUMPTION AND MOVEMENT OF THE PRECIOUS METALS.

CHAPTER X.

UNIFICATION OF GOLD AND SILVER COINAGE.

APPENDICES.

GOLD.

CHAPTER I.

THE GOLD REGIONS OF NORTH AMERICA, WITH STATISTICS OF THE PRODUCTION OF GOLD.

COLLECTIONS FROM CALIFORNIA AT THE PARIS EXPOSITION—EXTENT OF THE CALIFORNIA GOLD FIELD—THE GOLD-BEARING VEINS—THE COLLECTION FROM CALIFORNIA IN CONTRAST WITH THE GOLD ORES OF COLORADO—PRINCIPAL MINES AND DISTRICTS REPRESENTED BY SPECIMENS AT PARIS—PLACERS—STATISTICS OF THE PRODUCTION AND MOVEMENT OF GOLD PRODUCED IN CALIFORNIA AND OTHER PACIFIC STATES AND TERRITORIES—QUARTZ MILLS IN CALIFORNIA—OREGON—IDAHO AND WASHINGTON TERRITORIES—MONTANA—BRITISH COLUMBIA—NEVADA—ARIZONA—NEW MEXICO—COLORADO ORES AT THE EXPOSITION—APPALACHIAN GOLD REGION—CANADA—NOVA SCOTIA—MEXICO—RESUMÈ OF THE TOTAL GOLD AND SILVER PRODUCTION OF THE UNITED STATES.

CALIFORNIA.

The gold of California was represented in the Exhibition by a systematic collection of the ores from the principal mines, made chiefly by the Commissioner of the State, and by a second, and, in some respects, similar collection contributed by the miners and mining companies of California to Dr. Pigné for the Imperial School of Mines of France. The number of specimens of gold and its ores in the two collections was about 500, and they included not only gold-bearing quartz but specimens of placer gravel and cement, and of the miscellaneous ores and minerals of the Pacific coast.

EXTENT OF THE CALIFORNIA GOLD FIELD.

The principal gold region of California is upon the western slope of the mountain chain of the Sierra Nevada, and is nearly co-incident with it in extent. Commencing at the south in Tulare and Kern counties, nearly under the parallel of 35°, it extends northwards through the whole range of counties of the State to the Oregon line—the parallel of 42°—thus extending over seven degrees of latitude, or about 500 miles.

The great bulk of the gold is, however, obtained from the central counties: Mariposa, Tuolumne, Calaveras, Amador, El Dorado, Placer, Nevada, Sierra, Yuba, Butte, and Plumas, lying between the parallels of 37° and 40°. This is the region of the most extensive and productive placers. Gold is also found upon the coast in Del Norte county, and at several places in the Coast mountains southward.

At San Francisquito in Santa Barbara county, south of the main gold field, placer gold was discovered as early as 1838, and gold was known

to exist along the Colorado river as early as 1775. Gold is not confined to the western water-shed of the Sierra, for it is found at many places on the eastern side as well as near the summit. Alabama district, in the great valley of Owens lake, east of the crest of the mountains, is noted for the richness in gold of its narrow veins. At Armagosa, in the Great Basin, gold was mined several years ago, and veins in Holcomb valley, north of San Bernardino, have been extensively prospected within the past five years. The working of deposits of placer gold further north and on the east slope of the mountains, along and near the valley of Carson river, led to the discovery of the great Comstock lode, which has given so many millions of silver to the world.

GEOLOGY AND THE GOLD-BEARING VEINS.

The principal rocks of the gold belt on the west slope are clay-slates, sandstones, and conglomerates of the Secondary period uplifted at high angles and dipping east. They are generally much altered—metamorphosed—and are associated with serpentine; also a metamorphic rock. Gold-bearing veins occur in or are closely associated with all of these rocks, and in hard and compact granite, in greenstone and dioritic rocks, and in dolomite and metamorphic limestones. They are found even in the partially metamorphosed stratified formations of the Cretaceous period in the Coast mountains, and they may also be found in the Tertiary strata.

It was formerly the generally accepted opinion that productive gold veins were confined chiefly to the metamorphosed older Palaeozoic formations—the Silurian rocks. The gold bearing rocks in the Ural mountains and in Australia have been shown to be Palaeozoic, belonging in Australia to the lower Silurian division.

The discovery of fossils of the Carboniferous period in California by Dr. Trask in 1854, the exploration of the gold region by the writer in 1853-'54, and the subsequent discovery of Secondary fossils in the main belt of gold-bearing slates, together with the discoveries in Hungary in 1861-'62, proving that the rocks holding the gold belong to the latest geological periods, even as late as the Tertiary, all show the fallacy of the opinion that productive gold veins are associated chiefly with the older rocks.

The gold bearing veins of California are largest and most extensive in the region of the metamorphosed Secondary rocks. They generally conform to the dip and strike of the strata, and vary in width from a few inches to 20 or 30 feet. When they traverse granite or metamorphic rocks, in which the stratification is nearly or quite obliterated, they are generally narrower and more uniform in width than when in the softer rocks or slates. The most extensive vein of the State, and perhaps in the world, is known among the miners as the "Mother vein," and extends, but with some considerable breaks and interruptions, from *Mariposa north*westward for 80 or 100 miles, following a zone or belt of

Jurassic slates and sandstones, and closely associated with a stratum of dolomite or magnesian rock, often a magnesite, filled with reticulations of quartz veins, and charged with pyrites. The outcrops of this rock are generally very rusty and porous in consequence of the decomposition of the pyrites, and show green films of an earthy mineral containing chromium.

Nearly all of the auriferous veins of California are composed of white, or bluish-white quartz, with, in general, not over two per cent. of sulphurets. These sulphurets are chiefly ordinary iron pyrites, with, occasionally, a little galena and blende. In some veins iron pyrites is replaced by arsenical pyrites or mispickel, as, for example, in the mines of the Clear Creek district in Tulare county. An example of a vein containing much more than the usual amount of sulphurets is found in the Soulsby, near Sonora, Tuolumne county, (specimens Nos. 110 and 111 of the California collection.) In these the sulphurets form more than half of the bulk of the ore.

The collection contained not only the white and bluish-quartz specimens taken from below the water-level in the veins, and showing the bright glancing pyrites, but exhibited, also, the appearance of the ore from the upper portion of veins above the permanent water-level, and near the outcrops, where, under the influence of air and moisture, the ore decays and becomes browned and rusted by the decomposition of the pyrites. By this natural decomposition the gold contained in the pyrites is liberated and left in a condition to be readily separated from the ore by mechanical means. Such ores are, of course, more readily and cheaply worked than those in which the sulphurets are not decomposed, and they give a better yield in ordinary working. The collection contained, also, a series of the concentrated sulphurets as obtained by washing from various mines, some of which were very rich in gold, and are worked at the localities by the chlorination process of Professor Plattner.

Most of the specimens exhibited were hard and flinty, and the veins from which they were taken are in hard rocks, requiring the use of powder for extracting or mining the ore, and powerful machines to break it up to a size suitable to be placed under stamps. Some of the ores, however, are remarkable for their softness and friability, being soft enough to be crushed in the hands, and to be excavated from the veins by a pick alone. Several specimens from the Sierra Buttes mine, and others from the Jefferson, at Brown's valley, were merely granular powders, looking like powdered salt or sugar.

The whole collection from California contrasted very strongly in appearance with the collection from Colorado Territory, arranged opposite it, which was characterized by the abundance of massive sulphurets of iron and copper, to the almost entire exclusion of quartz. The white flinty quartz of California, with its hidden particles of free gold, could not be said to have a metallic appearance; while the ores from Colorado

had the semblance of extreme metallic richness, and many no doubt mistook the glittering pyrites for the noble metal.

The average fineness of California gold was formerly about .885. For a few years past it has not averaged so high, ranging from .865 to .870, and containing about one per cent. of the base metals; its composition being, nearly, .87 gold, .12 silver, and .01 base metals. This decrease of fineness is due, undoubtedly, to the increased quantity of gold from veins, and, perhaps, to the mingling of gold from Idaho, which contains a large amount of silver.

Following are brief notices of some of the principal mines of California represented by specimens in the Exposition. The notices follow in the order of succession of the mines from the southern end of the gold region northward.

TULARE COUNTY.

Long Tom mine.—This claim, situated on Posa Flat, about 25 miles west of Havilah, is one of the most prominent and successful mines in the southern part of the gold region. The vein is nearly vertical, from three to eight feet wide, and cuts through granite. The quartz is impregnated with arsenical pyrites, (mispickel,) and it has been rich in gold from the surface to a depth of 200 feet, or as far as the shaft has been sunk. The general characters of the ore, and of the sulphurets, are well shown by the suite of specimens in the collection, Nos. 87 to 90, some of which are from below water-level, and others from above.

A mill of ten stamps was erected a short distance below this mine, and it has been in constant and successful operation. The receipts of bullion in the month of October, 1866, were $16,500; in November, $17,500, and and in December about $20,000. The entire expenses of the mine and mill were said to be less than $3,000 a month.

Joe Walker mine—Walker's Basin, southeast of Havilah. This vein was accidentally discovered by a farmer when out looking for stock. It was sold in June, 1866, for $2,000, and by December was opened by a shaft to a depth of 200 feet.

A 20 stamp mill was completed in October, and gave an average daily yield of about $1,200 from about 30 tons of ore. The vein is from three to eight feet in width, and the quartz is quite friable and easily crushed.

Mammoth lode—On Kern river, a few miles northwest of Havilah. This is a very large and well defined vein, extending for a great distance over a high ridge, in a position which permits it to be worked by tunnels. A new mill was erected upon the river last year, and preparations were making to work the vein upon a large scale. This vein is reputed to have yielded about $1,000,000 in all, prior to the great floods of 1861–'62, which swept away the mills, and put an end to the mining operations.

Clear Creek mines.—There are several interesting and important mines in the immediate vicinity of Havilah, some of which—the *Rochefort* and the *French Friend*—were represented in the collection. The ores of the

district are all characterized by a great abundance of arsenical pyrites, and are generally quite rich.

MARIPOSA COUNTY.

There are not many important mines yet known northward from the Clear creek and Kern river region until Mariposa county is reached, and none are represented in the collection.

Mariposa vein.—This is one of the principal veins on the Mariposa estate, and is noted for the rich bunches or pockets of gold which have been found in it from time to time, some of which have yielded from $30,000 to $75,000; but mining this vein, on the whole, has not been successful.

Princeton vein.—This is also on the Mariposa grant, and is one of the most celebrated in California. It traverses clay-slates nearly parallel with the bedding, but gives evidences of having been formed in a fissure or plane of dislocation of the strata. It is from two to seven feet wide where worked, but the average is not over three feet. There are five or six shafts, the deepest of which is between 600 and 700 feet, and the principal level is over 1,200 feet long. This vein has yielded an aggregate of about $3,000,000, but it is not now worked. The ore has averaged about $16 per ton, and has given large profits.

The vein is composed of hard white quartz, and is divided into parallel layers or plates by thin slaty films, which are generally charged with fine-grained pyrites and free gold, forming what is known among the miners of California as "ribbon-quartz." The more solid and compact masses of quartz often contain iron pyrites in brilliant crystals. Galena occurs also, but not in large quantities. Gold in irregular, ragged masses, and sometimes in crystals, occurs with these minerals. It appears to be most abundant in contact with the galena, and when much galena is seen in the quartz a large yield is expected. Gold is frequently found spreading in films over the surface of crystals of iron pyrites, or extending through the crystals in thin sheets. It occurs also entirely isolated from either the pyrites or galena, and in the midst of solid white quartz. The specimens of crystallized gold broken out of this vein were bunches of octahedrons, with perfectly flat and highly polished faces from one-eighth to three-sixteenths of an inch across, and were attached to masses of white quartz.

Pine Tree and Josephine.—These veins, also on the Mariposa estate, are on the south bank of the Merced river, and intersect so as to form in reality one large vein, which is a portion of the great Mother lode. This lode extends northwestward from this point for 70 or 80 miles, broken, however, and disappearing at intervals, yet always presenting the same general characteristics, and affording similar ores. The position of the Pine Tree and Josephine veins is such, on the high bank of the river, that they are worked and drained through tunnels, and the quartz is taken by a tramway to the bank of the river to be crushed in mills driven by

water-power. The mine is extensive, and very large quantities of quartz have been extracted and worked, but there are no complete and reliable statistics of the yield. The quartz has averaged from $8 to $9 per ton as worked, but it is possible to select the ore so that the yield would be much higher. It is reported that the yield of this ore has been much increased during the past year by an improved system of working. The ore is first dry-crushed, and then triturated to a fine powder in what is known as a Lumsden's crusher. This consists of a revolving iron cylinder, in which the dry powder is placed, together with a great number of hard cast-iron bullets. After revolving long enough to secure the desired fineness of the powder, the amalgamation is effected by Ryerson's process. This consists in exposing the powder to the hot vapor of quicksilver in a closed vessel. This vapor is subsequently condensed by a jet of cold water, and the amalgamated gold is separated from the pulp by washing in the usual manner. It is claimed that, by this process of working, the yield is nearly double what can be obtained by the ordinary method of wet-crushing and battery amalgamation.

Coulterville and Hites's Cove.—Between the Pine Tree mine and the town of Coulterville there are several other mines and outcrops of importance along the course of the Mother lode. Among these the Emily, the Adelaide, and the Crown lodes may be mentioned. There are also important mines at Hites's Cove, further up the river, but these were not represented by specimens at the Exhibition.

Peñon Blanco.—At Coulterville, and in its vicinity, the Mother lode is well defined and there are many promising claims. One of the most interesting locations is the Peñon Blanco, three miles northeast of the town, and on the divide, between Tuolumne and Merced rivers. This Peñon Blanco is a high hill, which is cut directly through by the vein; and the masses of white quartz standing out over the summit make it a prominent landmark for miles along the course of the great vein.

This claim is 5,850 feet long; course of the vein, north 36° west; dip easterly, 47°; average thickness of vein, 20 feet. The croppings rise from 5 to 30 feet above the surface. In some parts of the vein it is divided up by masses of slate. There are two principal ore shoots, plunging southward. Very little work has yet been done upon the claim.

TUOLUMNE COUNTY.

App's mine.—This is upon the great vein near Jamestown. (Specimens Nos. 102 and 103.) It was worked irregularly between the years 1856 and 1859, but has since been regularly worked, with a very uniform yield of the quartz. From May 1, 1859, to September 1, 1866, 8,027 tons of ore were crushed, and yielded an aggregate of $124,575, averaging $15 52 per ton. The expenses of mining and milling are said to have averaged $7 47 per ton.

Raw hide Ranch mine.—(Specimen No. 106.) This mine is also upon

the great vein, and was purchased in 1866 by parties in New York. The vein in the deepest shaft (200 feet) is said to be 10 feet wide. About 1,500 tons of ore were extracted in 1866. Some portions of the vein are very highly charged with gold, in an extremely divided state. The quartz has a greenish blue tinge, and is very hard. Large quantities of rich tellurium ore, rich in gold, have been discovered in it.

Golden Rule mine.—In 1866, 3,000 tons of ore were extracted from this mine, and yielded $32,554; an average of $10 75 per ton.

Chaparral Hill and other mines.—The collection contained specimens of the ores of the Chaparral Hill, the Bacon, Monte Christo, Buchanan, Consuelo, and other mines; but no statistics of their production or yield are accessible in season for this report.

Soulsby mine.—This mine is opened upon a narrow but very well-defined vertical vein, cutting granitic rocks, and highly charged with sulphurets of iron and lead, and rich in free gold. It has been successfully worked for a long time, and has yielded more than $1,200,000 in bullion. The pay ore has been traced for 1,700 feet in length. It has yielded about $400,000 during the past three years. The specimens (Nos. 110 and 111) contain galena and iron pyrites, with free gold, and more nearly resemble the gold ores of Colorado than any other specimens from California.

CALAVERAS COUNTY.

Carson Hill mine.—This claim was represented by some rich specimens, contributed by R. H. Sinton, esq. The quartz is hard and resinous in lustre, and the gold is extremely coarse and heavy. The vein is noted for its great size and for the large masses of gold which have been broken from it. It is upon the line of the great vein, and forms the connecting link between the mines of Tuolumne county and those of Angel's camp. The outcrops of quartz are very heavy, and stand boldly out upon the top of a high hill. In the early days of mining the slopes of this hill were crowded with miners, working over the surface soil for the large masses of ragged vein gold found in it, and which doubtless came from the breaking down of the vein.

The pits along the outcrop of the vein had not been sunk over 130 feet in depth before the property became involved in litigation upon conflicting claims, and has so remained until the last year, when preparations were made for commencing a methodical and thorough development of the ground. Some of the largest masses of native gold ever seen were taken out of the quartz of this vein.

The gold is associated with tetrahedrite, highly argentiferous, giving crusts of chloride of silver by its decomposition, and staining the quartz blue by the formation of blue carbonate of copper. This blue color in the vein is regarded as an unfailing indication of the presence of gold. It is found at several other points upon the great Mother vein, as, for example, at the Emily and the Pine Tree. At the Melones and Stanislaus mine, near this claim, there are some interesting ores, containing tellurium combined with silver and gold.

South Carolina claim.—This is in the immediate vicinity of the Carson Hill claim, and has yielded a large amount of gold, which appears to be found in a soft greenish or talcose slate, alongside of the great outcrop of quartz which traverses the claim.

Angel's Camp mines.—Several adjoining claims from this region were represented by specimens, all having a general similarity. These claims are known as Hill's, Slocum and Bell's, Cameron's, and Winter's, (now Bovee's.) The ore is peculiar, being generally a mixture of quartz and magnesite or dolomite, highly charged with bright glancing crystals of iron pyrites, often extremely rich in gold. Gold is also found free in the magnesite, and is very pure. No reliable statistics of the total production of these claims are obtainable. Much difficulty has been experienced in working the ore, owing to the refractory character of the sulphurets, which require to be decomposed before the gold can be obtained.

AMADOR COUNTY.

Coney mine.—This mine is remarkable for the quantity and richness of the sulphurets in the quartz. Until recently these sulphurets have been shipped to Europe and sold, but they are now worked upon the spot by the chlorination process of Professor Plattner.

Keystone mine.—(Specimen No. 114.) The quartz from this mine much resembles that from the Princeton vein. This mine was vigorously worked in 1866, and some 9,000 tons of ore were raised and milled, yielding $175,000. The yield of the mine since 1851 has been about $1,100,000 A new 20-stamp mill was erected in 1866, and other improvements made, at a cost of $75,000, besides which $50,000 were divided among the owners.

Hayward's mine, Sutter creek.—This mine, known also as the Eureka, was opened in 1853, and the main shaft had reached a depth of 1,230 feet at the end of 1866.

The vein traverses metamorphic rocks, conformably to the bedding. The hanging wall is a hard rock, resembling greenstone in color and texture, but probably metamorphic, and the foot wall is a soft black slate. This is one of the thickest veins in California, requiring timbers from 18 to 20 feet in length to reach from wall to wall after the extraction of the quartz. The average thickness of vein may be considered as about 16 feet, and the length, horizontally, of the pay shoot is not over 450 or 500 feet. The mine at this great depth is remarkably free from water, the lowest levels being dryer than the upper. This, together with the great size of the vein, permits the quartz to be mined very cheaply. Levels are run, one below another, at intervals of 100 feet, and the quartz is found to increase rather than to diminish in value in descending.

The yield of the mine in 1866 was about $450,000, and the gross product, since its opening, is believed to be not less than $3,000,000. The ore of the lower portions probably averages $15 to $17 per ton. The per

centage of sulphurets in the quartz is small, and free gold, in grains large enough to be distinctly seen, is not common. This mine has recently become the property of a joint stock company—the Amador Mining Company—and is represented by 3,700 shares, at a par value of $400. The bullion returns during two weeks in October, 1867, amounted to $16,580. It was incorporated October 1, 1867, and since that time, to the end of the year, produced $111,826 63 in bullion; the dividends disbursed during the same period amounted to $66,600. The receipts in December were $35,121 33. The quantity of ore reduced during the last three months of the year was 5,018 tons. The average value of the ore for 13 months was $22 06 per ton. The cost of mining and milling was $6 06; leaving a profit of $16 per ton. This stock has never been assessed. It has been sold as low as $200 per share.

NEVADA COUNTY, GRASS VALLEY DISTRICT.

The Grass Valley district is one of the oldest and most important quartz mining sections of California, and has produced about $25,000,000 of gold during the last fourteen years. The veins are generally narrow, but rich, and carry coarse, free gold, associated with sulphurets of iron and lead. They traverse hard dioritic and granitic rocks, which are probably metamorphic.

Eureka mine.—This is one of the most remarkable and profitable mines in California. It was first opened in 1854, and was worked at intervals for several years with little or no profit, but was reopened a few years since, and then sold to parties who sunk a shaft to the depth of 300 feet, and found the vein to constantly increase in richness. The gross yield of bullion for 1866 amounted to $596,053; of this $360,000, or an average of $30,000 a month, were divided among the shareholders, besides considerable expenditures in permanent improvements. This amount was extracted from 12,200 tons of ore, giving an average yield of $48 per ton. The total production of the mine from October 25, 1865, to April 17, 1867, was $825,926.

North Star mine.—This mine is worked to a depth of 750 feet, (upon the vein,) and 600 to 800 feet longitudinally. Over $500,000 has been realized in profits during the past five years. The gross product of a new 16-stamp mill in 1866 for five months was over $100,000, and the profits divided ranged from $12,000 to $14,000 per month.

Ophir mine.—This mine is said to have yielded about $1,000,000 from 1852 to 1864. In 1866 some 3,750 tons of ore were reduced, producing about $175,000, or an average of $47 per ton.

Gold Hill.—This is one of the oldest quartz mining localities in California, and is popularly believed to have yielded some $4,000,000 during the fourteen years ending in 1864. The vein is considered to be the continuation of the famous Watt vein upon Massachusetts Hill, some 500 feet south of it, which yielded a net profit of $960,000 in three years.

Other mines.—Many of the important mines of the Grass Valley district, and of the county, were not represented in the collection at Paris. There were a few specimens from the Norambagua, the Lone Jack, the Providence, and the Lone Star.

The report of the county assessor for the year 1865 states the number of mines in the county as 117. Many of these were merely prospective. There were 71 mills—51 for crushing and working quartz, and 20 for crushing cement gravel. The yield of 19 mines, fully reported, was $2,227,000. Twenty-three of the mills had crushed an aggregate amount of 70,760 tons.

YUBA COUNTY.

Jefferson mine.—Specimens 157 to 164. The quartz from this vein is white and friable, some of the best ore being in a powdered state when extracted. The vein is about six feet wide, and is enclosed in metamorphic rocks, dipping to the east at an angle of about 45°. Course, nearly north and south. It is worked to a depth of 450 feet, (1866,) and has eight levels, the lowest 100 feet apart. There are two or more chimneys of superior ore, and they plunge northwards. About 1,000 tons of ore are worked monthly, and the average yield per ton for the year was $18. The whole cost of raising and working is estimated to be $4 50 per ton, thus leaving a profit of $13 50, or about $13,500 a month.

Pennsylvania.—This mine joins the preceding, and has similar ore. It was represented by specimens 164 to 167. The claim is 1,500 feet in length, and the shaft had been sunk to a depth of 110 feet at the end of 1866. The vein at the bottom of the shaft is nine feet thick, and the best ore is said to average $20 per ton. It is worked, by a mill of eight stamps, located at the mouth of the mine.

SIERRA COUNTY.

Sierra Buttes mine.—This justly celebrated mine is located on the south fork of the Yuba river, about 12 miles from Downieville, and was represented by suites of specimens, selected by the writer, from the different parts of the mine, (Nos. 167 to 187.) The claim is 3,000 feet in length, and it is estimated to be at an elevation of 6,000 feet above tide. The vein traverses hard metamorphic slates, and is divided into three branches, each of which is worked. The thickness of these veins, where united, varies from 16 to 30 feet, but the usual thickness of the branches is from 6 to 8 and 12 feet. It is so situated upon the steep slope of the mountain that it can be worked by tunnels, one below another, to a very great depth. There are now four principal tunnels upon the course of the veins, the lowest being at a depth of about 750 feet from the top of the outcrop where it passes the crest of the hill. The vein is cut also by a fifth tunnel, about 400 feet lower, thus showing the permanence of the vein at a depth of about 1,100 feet.

The gross yield of the mine from 1861 to 1866, inclusive, was $1,345,000,

the expenses were $460,000, and the profits divided among the owners, from 1856 to 1867, were $884,400, as follows:

Yield of the Sierra Buttes mine.

Year.	Gross.	Expenses.	Profits.
1857, (6 months)	$51, 000	$14, 600	$36, 400
1858	88, 000	20, 000	68, 000
1859	55, 000	15, 000	40, 000
1860	120, 000	37, 000	83, 000
1861	198, 000	44, 000	154, 000
1862	164, 000	52, 000	112, 000
1863	158, 000	58, 000	100, 000
1864	90, 000	75, 000	15, 000
1865	198 000	66, 000	132, 000
1865	223, 000	79, 000	144, 000
Totals	$1, 345, 000	$460, 000	$884, 400

The low yield and small profits of 1864 are explained by the drought of that year, which necessitated the construction of a long flume, at a cost of $40,000, to bring water for the mills. The uartz, as worked, has averaged from $16 to $18 per ton, but large quantities of lower grade ore are left standing in the mine.

Independence mine.—This mine is upon the prolongation of the Sierra Buttes vein, and was represented by specimens 187 to 189. It is a very large vein, averaging about 20 feet in thickness for about 300 feet. The paying portion is about 400 feet long, and it has been stoped out down to the lowest tunnel. The quartz is hard, and yields an average of $8 per ton. The estimated cost of working and raising is $5, thus leaving a profit of $3 per ton. Thirty tons are worked a day in a 24-stamp mill.

Keystone mine.—This mine is reported to have given a monthly yield of $8,000 to $10,000 during 1866, about half of which was profit. The ore is reported to average $15 per ton.

Barnhardt and other mines.—The Barnhardt claim, the Primrose, Belzona, Four Hills, Fac Simile, Mexican, and other mines of the region were represented by specimens contributed by Messrs. Crossman & Cochrane, of Downieville.

PLUMAS COUNTY.

The mines of this county were not represented by specimens as fully as they should have been. The Crescent mine of Indian valley has a good reputation, and is reported to have yielded over $100,000 in 1865.

King's mine was represented by a specimen of semi-opal containing free gold; interesting as an evidence of the aqueous origin of gold in veins.

SOFT OCHERY SLATES CONTAINING GOLD.

Attention has recently been directed to a class of gold deposits hitherto unknown or neglected in California, they having been supposed to be the outcrops or indications of deposits of copper ore merely, and were explored as such. They appear upon the surface as extensive outcrops of soft ferruginous slate of a dark red or brown color. Some of these deposits on being prospected and worked have been found to contain gold in sufficient quantities to encourage working.

These deposits occur in the foot-hills of the Sierra Nevada, a little west of the main gold belt, and in the zone known as the "copper belt," along which many large deposits of copper have been found under similar outcrops.

These outcrops are usually not accompanied by any well-defined lode of quartz, but the rocks are "mineralized" in a high degree, and are so much softened and decayed in places that they can be readily excavated with a shovel. The external surface is more highly rusted than the interior, which displays a variety of colors, from pure white to bright red and brown.

The suite of specimens Nos. 204 to 211 represented these extraordinary ores.

Harpending claim, near Lincoln, in Placer county.—The outcrop forms an isolated hill, rising from 80 to 100 feet above the plain, and about 200 feet wide and 500 long. It is excavated in open cutting or quarried out, the softness of the material permitting it to be worked with ease and at a very small cost. It is milled upon the spot, very coarse grates being used, and the pulp is ground after passing the battery. A 40-stamp mill has been erected at the locality during the past year.

Other and similar deposits are being explored in Calaveras county, the most prominent being at Quail Hill, near Telegraph City, where the soft slates give encouraging returns in gold and silver by working tests. Ten samples of about five pounds each gave an average result of: gold, $17 08; silver, $5 82; total, $22 90. The average yield of a sample from the inclined shaft was $35 87. A 20-stamp mill has been erected upon the property, but in working on a large scale the returns have not been equal to the expectations of the proprietors. These deposits are in many respects similar to the famous "Pigeon Roost streak" of Lumpkin county, Georgia, where a zone of rotten slates, but containing quartz, has furnished gold, by sluicing, for many years past.

PLACERS—CEMENT DEPOSITS.

The great bulk of California gold has been, and still is, obtained from placers—the natural deposits of the debris of pre-existing quartz veins which have been cut and washed away by the action of running water. When we contemplate the enormous amount of surface erosion throughout California, and see valleys excavated by rivers to a depth of 2,500

or 3,000 feet below the general surface of the country, it is not so difficult to admit that all placer gold has been broken from veins.

The great placer region of California is found in the central counties, from Mariposa to Butte county, inclusive. The deposits are not confined to the beds of streams alone, but are followed upon the tops of the hills, and give indisputable evidence of being the remains of ancient water-courses or river channels, formed when the direction of the drainage of the country was very different from the present. Some of these ancient deposits are buried under enormous accumulations of sand, clay, gravel, and sometimes of tufa and lava; and the rounded, river-worn boulders and stones are thoroughly cemented together, so as to form a solid conglomerate—a pudding-stone, the "cement" of the miners. This agglomeration or cementing appears to have been effected chiefly by the percolation or presence of either silicious, calcareous, or ferruginous waters. The first two, acting at considerable depths beyond the access of air, give bluish-green cements, the iron being in the state of protoxyd; but the ferruginous waters with access of air produce rusty or reddish-brown cements. The former are known by the miners as the *blue leads* and the latter as the *red leads*. Cements of a gray color are also found. Specimens of each were in the Exhibition, and some of them were rich in gold, the grains being as firmly imbedded or cemented in the mass as the pebbles. The collection contained characteristic specimens of each of these varieties of cement. It is the popular belief that there is one great *Blue lead* extending across several counties of the State, nearly at right angles with the present rivers. It is probable, however, that there are many independent channels having the same general appearance. Efforts are making to trace out the courses of these ancient deposits, and a map of Sierra county, showing the probable position of the old rivers relatively to those now existing, was prepared and published in May last, and sent to the Exposition by J. H. Crossman, Esq., of Downieville. Blue, gray, and red deposits are found in that county, and they are regarded as the deposits of as many different streams or ancient rivers.

The Blue lead is formed of a deposit of gravel and boulders, varying in size from a grain of wheat to masses of many tons weight. This fills the entire channel, from 700 to 1,000 feet in width. The gold is usually coarse and abundant, and has a high degree of fineness. The richest portion of the deposit is commonly not over three feet in thickness, and rests upon the bed or foundation rock. The miner upon the Blue lead always cuts away a portion of the bed rock together with the gravel, as the rock is very rich and quite soft. The whole is trammed to the dump at the mouth of the tunnel, to be washed in sluices.

Mr. Crossman regards the red lead as probably the high bars or banks of the ancient rivers, for the deposits cover a considerable area, and are generally parallel with the main channel. The boulders are not so large and the gravel not so rich as in the deep or blue channel. It has been observed, also, that the gold is not as fine.

Mr. Crossman furnishes the following estimate of the yield of one mile in length of the Blue lead, from Forest City southward. The work was commenced in 1854, and the claims were exhausted in 1860, except a few, which are still very remunerative. These claims were worked by tunnels, and in a hurried manner, so that perhaps one-third of the gold was left behind. It is probable that the ground will eventually be re-worked by the hydraulic method. The expense attending the extraction in the properties enumerated is said not to have exceeded one-third of the gross proceeds, two-thirds being divided among the shareholders.

Estimated yield of one mile of the Blue lead.

Name of claim.	Yield.	Name of claim.	Yield.
Live Yankee	$300,000	Red Stay	$150,000
Buckeye	200,000	Packard	150,000
Empire Company	240,000	Jenny Lind	60,000
Dutch Company	40,000	Hook & Ball	150,000
Seven small claims	25,000	Blue Tunnel	70,000
Little Rock	100,000	Keystone	50,000
Can't Get Away	50,000	Alleghany	200,000
Do Say	200,000	Pacific	400,000
Washington	200,000	Bay State	100,000
Monte Christo	150,000	New York Branch	50,000
Gordon Gates	50,000	New York	250,000
Monumental	100,000	N. Weston	75,000
Knickerbocker	100,000	Cumberland	50,000
Uncle Sam	150,000	Union	200,000
American Company	50,000	Excelsior	225,000
Manhattan	50,000	Eureka	200,000
Nonesuch	50,000	Tremont	400,000
Masonic	150,000		
Highland	100,000	Total	$5,195,000
Ohio	50,000		

One of the best examples of placer mining, on a large scale, is found at the claim of the Blue Gravel Mining Company at Smartsville, in Yuba county. This claim covers an area of 100 acres, with an average depth of deposit of 100 feet. The channel of the ancient stream is from 100 to 400 feet wide. A tunnel to reach the channel was commenced in 1855, and completed, after much difficulty and great expense, in 1864. The company has four miles of sluices, three feet wide and three feet deep, with an inclination of six and one-half inches in 12 feet. The bed of the sluice on which the gold is caught is made of alternate sections of wooden blocks, 17 inches long, and of rock 24 inches long, (measured along the sluice.) Three tons of quicksilver are used in the flume. Five hundred inches of water are used, at a cost of $75 per day. The sluice is cleaned up once in eight or ten weeks, and the results of the several runs, from the opening of the tunnel till the end of 1866, were as follows:

Results of sluicing—Blue Gravel Mining Company.

Month.	Amount.	Month.	Amount.
March, 1864	$9,381	August	$24,679
May	24,275	September	46,500
June	70,000	October	26,660
July	22,350	December	37,000
August	3,487	February, 1866	23,746
September	49,440	April	43,428
October	24,669	June	23,880
December	45,003	August	42,494
January, 1865	2,723	October	18,000
February	24,051	December	25,000
March	44,981		
May	24,000	Total	$642,860
June	50,118		

In order to extract the gold from the very hard cements which will not disintegrate by exposure to the sun and air during the dry season, recourse is had to stamp-mills, known as cement-mills. These are like ordinary quartz-mills, except that the grates are made very coarse and heavy, and a much greater flow of water is used. The number of such mills is now very great, and is increasing.

STATISTICS OF THE PRODUCTION AND MOVEMENT OF GOLD PRODUCED IN CALIFORNIA AND OTHER PACIFIC STATES AND TERRITORIES.

The receipts of uncoined bullion at San Francisco, from the interior of California, include also the bullion from the State of Nevada. We may therefore ascertain approximately the value of the gold production of California by subtracting from the total receipts the value of the Nevada bullion. There is a small production of silver bullion within the limits of the State; but as this is inconsiderable compared with the gold product, and as there are no reliable figures or estimate of the amount of this silver bullion, no attempt is made to segregate it from the total bullion returns. The shipment of treasure from the interior consists largely of coin, and this also must be subtracted. The following table shows the total receipts of treasure at San Francisco, both coined and uncoined, from the interior of California during the four quarters of the years 1864, 1865, 1866, and 1867, and comprises the aggregate for the whole of each year.[1]

[1] For these statistics, and for some of the following tables of production and export, I am indebted to Carmany's Review of the Mining, Agricultural, and Commercial Interests of the Pacific States for the year 1866, and to the Mercantile Gazette of January, 1867. Copies of the former were contributed by Mr. Carmany for distribution at the Exposition.

Receipts of treasure, coined and uncoined, at San Francisco, from the interior of California, during the four quarters of the years 1864, 1865, 1866, *and* 1867, *and comprising the aggregate of the same for the whole of each year.*

Months.	From the northern mines. Uncoined.	Coined.	Total.	From the southern mines. Uncoined.	Coined.	Total.
1864.						
October	$2,742,[illegible]	$280,315	$3,0[illegible]	$461,927	$138,972	$6[illegible]
November	2,543,755	318,530	2,862,286	400,773	149,8[illegible]	550,579
December	2,6[illegible]	392,453	3,053,175	36[illegible],411	162,770	524,18[illegible]
Fourth quarter	7,947,[illegible]	[illegible]	[illegible]	1,22[illegible]	451,548	1,67[illegible]
Third quarter	8,115,[illegible]	[illegible]4,565	9,1[illegible],676	1,354,110	378,848	1,7[illegible]
Second quarter	10,116,5[illegible]	7[illegible]	10,9[illegible]	1,449,762	285,960	1,735,722
First quarter	8,[illegible],571	1,0[illegible],487	9,[illegible]	1,3[illegible],795	394,0[illegible]	1,7[illegible]
Total for year	$34,[illegible],512	$[illegible]	$[illegible]	$5,347,778	$1,5[illegible],375	$6,[illegible],153
1865.						
October	$2,6[illegible]	$225,977	$2,914,[illegible]	$437,274	$156,642	$593,916
November	[illegible]	250,[illegible]	[illegible],071	[illegible],433	122,935	4[illegible]
December	[illegible]	[illegible]	2,402,[illegible]	[illegible]	95,[illegible]	4[illegible]
Fourth quarter	[illegible]	758,4[illegible]	[illegible]	1,121,[illegible]	375,211	1,497,[illegible]
Third quarter	8,572,457	[illegible]	[illegible]	1,237,201	319,[illegible]	1,55[illegible]
Second quarter	[illegible]	702,7[illegible]	[illegible]	[illegible]	[illegible],578	[illegible]
First quarter	[illegible]	912,[illegible]	[illegible]	1,312,[illegible]	[illegible]	[illegible]
Total for year	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1866.						
October	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
November	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
December	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fourth quarter	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Third quarter	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Second quarter	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
First quarter	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total for year	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1867.						
January	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
February	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
March	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
April	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
May	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
June	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
July	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
August	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
September	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
October	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
November	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
December	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

The totals of the uncoined bullion receipts are as below for the years amed, and by subtracting from each the bullion product of Nevada for he corresponding years, we obtain, approximately, the gold yield of the tate, to which, however, ten per cent. should be added to cover bullion hich may be taken to San Francisco in the pockets of miners, and not anifested:

Gold product of California.

	1864.	1865.	1866.	1867.
ncoined bullion, northern and southern	$40, 130, 080	$41, 757, 750	$39, 299, 730	$40, 591, 983
evada bullion	16, 000, 000	16, 800, 000	16, 500, 000	18, 000, 000
	$24, 130, 080	$24, 957, 750	$22, 799, 730	$22, 591, 983
dd ten per cent	2, 413, 008	2, 495, 775	2, 299, 973	2, 259, 198
Total gold product for each year	$26, 543, 088	$27, 453, 525	$25, 079, 703	$24, 851, 181

The following table shows the receipts of bullion and coin at the port f San Francisco from northern ports, chiefly Portland, in Oregon, and om British Columbia and Mexico, for the past three years:

Coastwise bullion receipts.

Year.	Uncoined.	Coined.	Total.
[illegible]—January	$333, 123	$128, 611	$461, 734
February	219, 926	59, 978	279, 904
March	167, 411	40, 911	208, 322
April	291, 949	60, 873	352, 822
May	362, 150	47, 975	410, 134
June	791, 928	52, 669	844, 597
July	823, 641	31, 269	854, 910
August	786, 558	32, 241	818, 799
September	954, 813	28, 876	983, 689
October	634, 116	23, 864	657, 980
November	794, 085	16, 818	810, 903
December	788, 802	24, 180	812, 982
Total	$6, 948, 511	$548, 265	$7, 496, 776
[illegible]—January	257, 930	30, 853	288, 783
February	174, 219	80, 972	255, 191
March	197, 023	20, 577	217, 600
April	274, 620	29, 974	304, 594
May	411, 427	90, 956	502, 383
June	460, 132	42, 388	502, 520
July	680, 953	37, 591	718, 544
August	932, 392	56, 959	989, 351
September	621, 426	7, 618	629, 044
October	559, 212	54, 055	613, 267
November	412, 183	45, 306	457, 463
December	415, 583	32, 193	447, 776
Total	$5, 397, 100	$529, 436	$5, 926, 536

2 G

Coastwise bullion receipts—Continued.

Year.	Uncoined.	Coined.	Total.
1867—January	$344,440	$15,381	$359,821
February	128,799	10,884	139,683
March	119,398	23,284	142,682
April	344,075	7,450	351,525
May	380,780	11,636	392,416
June	366,265	8,976	375,241
July	760,693	214,744	975,437
August	1,006,186	2,536	1,008,722
September	490,853	5,556	496,409
October	744,349	80,980	825,329
November	536,548	100,520	637,068
December	442,951	45,450	488,401
Total	$5,665,337	$527,397	$6,192,734

The amount of treasure exported from San Francisco in 1865 was $45,308,228, and in 1866 $44,364,393; showing a decrease of $943,835. The decrease for 1867 was much greater, as will be seen by the annexed table, which shows the amount and destination of the exports of treasure from the port of San Francisco for 1867, as declared at the custom-house:

Statement of the amount and destination of treasure exported from San Francisco during the year ending December 31, 1867, as declared at the custom-house.

TO NEW YORK.

In January	$2,869,235 55	
In February	1,396,207 24	
In March	1,646,058 86	
In April	1,186,780 34	
In May	2,535,232 56	
In June	2,661,643 57	
In July	2,389,686 29	
In August	1,610,041 45	
In September	1,337,755 30	
In October	1,024,552 18	
In November	1,957,882 43	
In December	2,800,881 68	
		$23,355,903 45

TO ENGLAND.

In January	$703,070 85	
In February	384,198 00	
In March	357,661 60	
In April	297,174 02	
In May	788,772 13	
In June	502,834 36	
In July	616,302 22	
In August	515,691 91	
In September	493,965 34	
In October	704,600 43	
In November	321,514 42	
In December	156,408 71	
		$5,841,183 99

TO FRANCE.

In January	$122,331 56	
In February	105,079 91	
In March	67,000 00	
In April	69,537 25	
In May	101,509 48	
In June	117,400 57	
In July	183,751 64	
In August	231,905 70	
In September	106,600 42	
In October	31,772 40	
In November	65,555 27	
In December	74,791 53	
		$1,283,235 73

TO CHINA.

In January	$866,076 27	
In February	376,206 32	
In March	110,642 72	
In April	1,081,513 57	
In May	761,027 73	
In June	628,931 73	
In July	1,746,078 69	
In August	385,540 53	
In September	1,180,308 18	
In October	1,119,629 84	
In December	766,546 77	
		$9,031,501 35

Statement of the amount and destination of treasure, &c.—Continued.

TO JAPAN.		
In January	$21,685 46	
In March	10,000 90	
In April	2,238 72	
In May	2,845 00	
In July	1,100 00	
In September	10,000 00	
In October	650 00	
In December	593,430 34	
		$641,949 52
TO PANAMA.		
In January	$30,000 00	
In February	30,000 00	
In March	30,000 00	
In April	29,000 00	
In May	30,000 00	
In June	30,000 00	
In July	30,000 00	
In August	32,127 40	
In September	40,000 00	
In October	30,000 00	
In November	31,424 30	
In December	30,000 00	
		372,551 70
TO CENTRAL AMERICA.		
In February	$20,000 00	
In April	45,550 00	
In May	28,400 00	
In June	8,000 00	
In July	3,000 00	
In October	8,660 00	
In December	58,370 00	
		$171,980 00
TO HAWAIIAN ISLANDS.		
In April	$1,300 00	
In June	1,000 00	
In July	1,000 00	
In August	5,000 00	
In October	18,906 00	
In November	29,826 42	
		$57,032 45
TO MEXICO.		
In January	10,000 00	
In February	3,000 00	
In March	13,000 00	
In October	5,000 00	
In December	11,000 00	
		42,000 00
TO VALPARAISO.		
In February	$399,849 08	
In March	323,601 89	
		723,450 97
TO TAHITI.		
In February		500 00
TO VICTORIA.		
In February	$50,000 00	
In October	80,000 00	
In December	25,000 00	
		155,000 00
Total, 1867		$41,676,722 16
Total, 1866		44,364,393 05
Decrease, 1867		$2,688,100 89

The following table shows the value and destination of treasure shipments from San Francisco during the past 14 years—1854 to 1867 inclusive:

Treasure shipment from California.

Years.	Eastern ports.	England.	China.	Panama.	Other ports.	Totals
1854	$46,533,166	$3,781,080	$965,887	$204,592	$560,908	$52,045,633
1855	38,730,564	5,182,156	889,675	231,207	128,129	45,161,731
1856	39,895,294	8,666,289	1,308,852	253,268	573,732	50,697,434
1857	35,531,778	9,347,743	2,993,264	410,929	692,978	48,976,692
1858	35,891,236	9,265,739	1,916,607	299,265	175,779	47,548,026
1859	40,146,437	3,910,930	3,100,756	279,949	202,390	47,640,462
1860	35,719,296	2,672,936	3,374,680	300,819	258,185	42,325,916
1861	32,628,011	4,061,779	3,541,279	349,769	95,920	40,676,758
1862	26,194,035	12,950,140	2,660,754	434,508	322,324	42,561,761
1863	10,389,330	28,467,256	4,206,370	2,503,296	505,667	46,071,920
1864	13,316,122	34,436,423	7,888,973	378,795	686,888	56,707,201
1865	20,583,390	15,432,639	6,693,522	1,224,845	1,103,832	45,308,227
1866	29,244,891	6,532,208	6,527,287	511,550	1,548,457	44,364,393
1867	23,355,903	5,841,184	9,031,504	372,552	3,075,149	41,676,292
Totals	$428,159,453	$150,548,502	$55,368,810	$7,755,344	$9,930,338	$651,762,446

It is not possible to give the exports of the years previous to 1854 with so much accuracy. The records of the custom-house were destroyed

in the fire of May, 1851, and the figures usually given of the production from the time of the discovery of gold in 1848 to May, 1851, are approximations. It is believed that the exports up to 1850, inclusive, amounted to $66,000,000, and for the first four months of 1851, to May, $11,497,000.[1] The total exports from 1848 to 1867, inclusive, may be summed up as follows:[2]

Exports of treasure from San Francisco, 1848 *to* 1868.

1848 to 1851	$66, 000, 000	1859	$47, 640, 462
1851, to May 1, (estimate)	11, 497, 000	1860	42, 325, 916
1851, (8 months)	34, 492, 000	1861	40, 676, 758
1852	45, 779, 000	1862	42, 561, 761
1853	54, 965, 000	1863	46, 071, 920
1854	52, 045, 633	1864	56, 707, 201
1855	45, 161, 731	1865	45, 308, 227
1856	50, 697, 434	1866	44, 364, 393
1857	48, 976, 692	1867	41, 676, 292
1858	47, 548, 026	Total	$864, 495, 446

There is doubtless a considerable amount of bullion and of coin carried out of the port of San Francisco by passengers of which no account is given. The value of this unmanifested bullion and coin has been variously estimated; Commissioner Browne considered that it might be $200,000,000 up to the end of 1865,[3] but this was probably an over estimate. It is usual to make an addition of 10 per cent. to the recorded shipments of bullion from the interior of the State to San Francisco, so as to cover the bullion and coin brought down by miners and others, and thus not entered on the books of the express companies. Such an allowance upon the total bullion export as recorded would be ample, for there is no doubt that the proportion of unmanifested bullion sent out of the State is far less than that which arrives from the interior. Adding, therefore, this liberal allowance of 10 per cent. to the total manifested exports of treasure, and adding, also, an estimated amount of $45,000,000 to cover coin in circulation, and gold and silver used in the arts—spoons, table service, &c.—and subtracting from the total the amount of treasure received from British Columbia, Mexico, and other sources beyond the limits of the United States, we shall obtain a close approximation to the

[1] Mining Magazine, January, 1857; vol. viii, p. 193.

[2] In making up this tabular statement I have adopted, for the period from 1854 to 1867, inclusive, the figures published in the Mercantile Gazette, and Carmany's Review. For the previous years I have taken the returns and estimates published in the Mining Magazine, vol viii, p 193. All these figures differ somewhat from those published by Commissioner Browne. For the year 1853, for example, Mr. Browne gives the production as $57,[illegible],034, and for 1864, $55,707,201.

[3] Mineral Resources of the United States, 1867.

total value of the production of the precious metals upon the Pacific coast of the United States, from 1848 to 1868, being $961,000,000, as shown below:

Total manifested exports of bullion	$864,495,446
Add for unmanifested exports, (estimated at 10 per cent.)	86,449,544
Add for coin and gold and silver in use, estimate	45,000,000
	$995,944,990
Deduct receipts from British Columbia, Mexico and other sources, estimated in part	35,000,000
Approximate total production of the Pacific coast of the United States, 1848 inclusive, to 1868	$960,944,990
In round numbers	$961,000,000

It is difficult to ascertain what portion of this total should be credited to the State of California alone, but in order to arrive at an approximate estimate of it, the production of Nevada, Idaho, Oregon, and Washington, and other interior sources, must be deducted. Assuming this production to have been, in the aggregate, including the 10 per cent., $154,000,000, the remainder, $807,000,000, is an approximation to the value of the gold production of the State of California since the discovery of gold upon the American river in 1848.

QUARTZ MILLS.

The number of quartz mills in operation in the State in April, 1857, was 138, with an aggregate of 1,521 stamps; the cost of erection of which was $1,763,000. The number in operation November, 1858, was 279, with an average of 2,610 stamps, the cost of erection of which was $3,270,000. The number in operation January 1, 1867, was 411, of which 207 were propelled by steam, 186 by water, and 18 by steam and water. The aggregate number of stamps was 4,997, and the cost of the machinery was estimated at $5,900,000. In addition to the stamps, 419 arrastras were employed, of which 350 were connected with different quartz mills.

The following is a statement of the number of quartz mills in the State of California in 1866:[1]

[1] Langley's Pacific Coast Business Directory, 1867.

Tabular statement of quartz mills in California, 1866.

Location of mill.	Name of mill.	When erected.	No. stamps.	No. arrastras.	Power.	Cost.	Gold, silver, or cement.	Occupants in 1866.
ALPINE COUNTY.								
Markleeville	Pioneer	1863	10	......	Steam	$50,000	Silver	Jones, Wade & Co.
Silver mountain	Star	1864	6	......	...do	15,000	...do	W. Whitesides.
Do	Washington	1866	10	......	...do	20,000	...do	G. Wadlin, Mining and Mineral Co.
AMADOR COUNTY.								
Amador City	Amador	1856	10	......	Steam	10,000	Gold	Middleton & Co.
Do	Bunker Hill	1855	8	......	Steam and water	12,000	...do	William A. Palmer.
Do	Fleehart's	1866	10	......	Steam	10,000	...do	Gardner & Fleehart.
Do	Hazard	1857	8	......	Water	6,000	...do	Do.
Do	Keystone	1856	40	......	Steam	40,000	...do	Gashwilder & Co.
Do	Spring Hill	1856	40	......	Steam and water	40,000	...do	Hooper & Co.
Clinton	Rocky Falls	1865	10	......	Steam	10,000	...do	W. J. Paugh.
Do	Union	1858	10	......	...do	10,000	...do	E. T. Steen.
Drytown	Plymouth	1860	20	......	Steam and water	20,000	...do	Hooper & Co.
Do	Potosi	1857	16	......	Water	10,000	...do	Creed & Wood.
Do	Seaton	1865	20	......	Steam and water	100,000	...do	Seaton Mining Company.
Fiddletown	Richmond	1865	10	......	...do	10,000	...do	Eagan & Co.
Jackson	Coney's	1864	16	......	Steam	10,000	...do	C. T. Meader.
Do	Hubbard's	1860	10	......	Water	8,000	...do	S. C. Fogus.
Do	Kearsing's	1862	10	......	...do	5,000	...do	C. T. Meader.
Do	Tubbs's	1866	10	......	Steam	10,000	...do	Tubbs & Co.
Do	Oneida	1851	40	......	...do	40,000	...do	James Morgan.
Lower Rancheria	Italian	1864	4	......	...do	7,500	...do	Bruno & Co.
Pine Grove	Tellurium	1864	10	......	...do	10,000	...do	Cushing, Ryder & Co.
Rancheria	Loyal League	1858	20	......	Water	15,000	...do	Hurst & Co.
Sutter creek	Badger	1858	16	......	...do	10,000	...do	A. Hayward.

Do	Downs's	1858	10		do	10,000	do	R. C. Downs.
Do	Eureka	1858	40		Steam and water	40,000	do	A. Hayward.
Do	Lincoln Quartz Mining Company		20		Water	10,000	do	R. C. Downs, superintendent.
Do	Mahoney	1859	16		do	15,000	do	Mahoney Brothers.
Do	Meader	1866	20		do	20,000	do	C. T. Meader.
Do	Wildman's	1859	12		do	10,000	do	C. T. Wheeler.
Volcano	Belding	1865	10		Steam and water	12,000	do	California Furnace Company.
Do	Eagle	1858	10		do	9,000	do	—— Pine, superintendent.
Do	Fogus's	1865	10		Water	10,000	do	J. T. Farley.
Do	Golden Gate	1865	10		Steam and water	20,000	do	Hurd & Co.
Do	Italian	1862	10		Water	8,000	do	Rose & Co.
Do	Monday	1860	20		do	4,000	do	Fogus & Co.
Do	Mitchell's	1863	20		Steam	20,000	do	Lawton & Co.
Do	Pioneer	1855	10		Steam and water	15,000	do	C. T. Meader.
Do	Sirocco	1860	20		do	20,000	do	J. T. Farley.
Do	Sulphuret	1864		2	do	9,000	do	W. H. Thoss.
Do	Tulloch	1865	15		Steam	8,000	do	Lawton & Co.
Do	do	1865	1	1	Water	5,000	do	Tulloch & Co.
Do	Tynan	1865	12		Steam	8,000	do	M. Tynan.
BUTTE COUNTY.								
Cherokee ravine	Binny & Co	1866	4		Steam	3,000	Gold	Binney & Co.
Jordan	Porter Mining Company	1865	12	1	do	20,000	do	E. C. Ross & Co.
Oregon City	Cambrian	1866	6		do	12,000	do	—— Halstead.
Do	Nesbit	1865	10		do	15,000	do	Nesbit & Co.
Oregon gulch	Sparks & Smith	1856	12	1	do	30,000	do	Oroville Gold and Silver Mining Co.
Virginia	Virginia	1856	10	4	do	15,000	do	A. H. Wells & Co.
Yankee Hill	'49 and '56 Quartz Mining Company	1857	15	4	do	15,000	do	H. N. Tilden.
CALAVERAS COUNTY.								
Altaville	Altaville Quartz Mining Company	1863	16		Water	15,000	Gold	N. Sarco, Prince & Co.
Angel camp	Hill's	1850	12		Steam	10,000	do	—— Hill.
Do	Southworth's	1856	17		do	20,000	do	D. Southworth.
Do	Stickles's	1866	12		Water	4,000	do	E. & G. Stickles.
Do	Winter's	1852	6		do	3,000	do	Winters & Bovee.
Angel creek	Angel Creek	1865	6		do		do	Spence & Co.

Tabular statement of quartz mills in California, 1866—Continued.

Location of mill.	Name of mill.	When erected.	No. stumps.	No. arrastras.	Power.	Cost.	Gold, silver, or cement.	Occupants in 1866.
Camp Flores	Flores	1861	12		Steam	$18,000	Gold	Mina Rica Company.
Carson creek	Carson Creek	1864	10		Water	10,000	...do	Jones & Co.
Cherokee Flat	Cherokee	1860	10		Steam	3,000	...do	Cherokee Mining Company.
Copperopolis	Duncan's	1865	10		...do	15,000	...do	Duncan & Co.
Do	Reservoir	1864	10		Water	10,000	...do	Sheppard & Co.
Dry creek	Dry Creek	1862	10		Steam	10,000	...do	Knox & Co.
El Dorado	El Dorado	1866	10		...do	10,000	...do	William Irvine.
M. F. Mokelumne river	Carlton's Arrastras	1860		2	Water	200	...do	B. F. Carlton.
Musquito	Mosquito Quartz Mining Company	1863	15		Steam	15,000	...do	Cutter & Waters.
San Andreas	Rathgeb's	1864	10		Water	7,000	...do	John Rathgeb.
Do	Taite & McGlynn	1861	8		...do	6,000	...do	Taite & McGlynn.
Do	Tubbs's	1860	10		...do	15,000	...do	Tubbs & Co.
Sandy gulch	Woodhouse	1858	15		...do	3,000	...do	C. Smith.
Skull Flat	Casner's	1859	8		...do	3,000	...do	Casner & Barnes.
West Point	Harris's	1860	5		...do	15,000	...do	A. Harris.
Do	Hope's	1860	15		...do	4,000	...do	—— Hope.
Do	Lacey's	1861	5		...do	4,000	...do	A. Lacey.
Do	Schmidt & Fisher	1864	2		...do	3,000	...do	Schmidt & Fisher.
Do	Vance's	1862	8		Steam	15,000	...do	—— Bernard.
EL DORADO COUNTY.								
Cold Springs	Columbus	1866			Water		Gold	J. C. McTarnahan, superintendent.
Coloma	Isabell Gold and Silver Mining Co	1861	5		...do	6,000	...do	Philo Isabell, superintendent.
Cosumnes	Stillwagon & Norton	1866	4		...do	1,500	...do	Stillwagon & Norton.
Do	Tulloch & Ault	1866	8		Steam	4,000	...do	Tulloch & Ault.
Diamond Springs	Cooke's	1866	5		Water	1,000	Cement	J. Cooke & Co.
El Dorado	Fort Yuma				Steam		Gold	
Do	Logtown	1856	10		...do	9,000	...do	Gokly & Burlingham.

Do	Montezuma	1866	40	Water	60,000	do	—— Spence, agent.
Do	New York El Dorado	1865	20	Steam	20,000	do	New York El Dorado Company.
Do	Sugar Loaf	1866	20	do	15,000	do	B. Dickerman, superintendent.
Do	Union	1865	8	do	12,000	do	J. T. Babcock, superintendent.
Do	Wilder's	1865	10	Water	2,500	do	B. W. Wilder.
Georgetown	Clipper Gold and Silver Mining Co.	1863	5	do	12,000	do	R. Cushman, superintendent.
Do	Woodside	1863	2	Steam	6,000	do	Ash, Lane & Knox.
Georgia Slide	Blue Rock	1866	10	Water	1,000	do	John Hines & Co.
Grizzly Flat	Eagle	1866	20	do	12,000	do	William Bigler.
Lyonsdale	Blue Ledge	1864	2	Steam	60,000	do	A. M. Stetson, superintendent.
Kelsey	Plymouth	1864	15	Water		do	—— Potter, superintendent.
Placerville	Harmon	1866	15	Steam	20,000	do	Harmon Gold and Silver Mining Co.
Do	Loafer's Hollow	1866	10	do	12,000	do	C. W. Moulthrop, superintendent.
Do	Manning	1864	4	do	5,500	do	Blain, Alderson & Co.
Do	New El Dorado	1863	15	do		do	A. Lazcas, superintendent.
Do	New York	1862	20	do	10,000	do	F. Reed.
Do	Pacific	1867	10	do	15,000	do	J. M. Douglass.
Do	Poverty Point	1861	10	do	8,000	do	Burdick & White.
Shingle Springs	Gray's	1863	10	do	1,500	do	Gray, Brothers & Son.
Smith's Flat	Brewster & Co	1866	12	Water	6,000	do	Brewster & Co.
Do	Hook and Ladder	1866	4	do	500	do	Anderson & Bedd.
Do	Taft's	1860	10	Steam	2,000	do	P. M. Taft.
Soap Weed	Cobb & Co	1866	12	Water	4,000	do	Cobb & Co.
Texas Hill	Stewart's	1866	10	do	3,000	do	Stewart & Hall.
Volcanoville	French	1859	20	Steam	40,000	do	French Company.
White Rock	Live Oak	1866	8	Water	2,000	do	Ward Brothers.
INYO COUNTY.							
Chrysopolis City	Oro Fino	1866	20	Water	35,000	Gold and silver	New York Company.
Coso district	Josephine	1865	5	Steam	30,000	do	Do.
George's creek	Passmore's	1866	4	Water	2,000	do	Thomas Passmore.
Inyo district	New York Company	1865	16	Steam	50,000	do	New York Company, M. Dore, agent
Kearsarge City	Paul's	1866	5	Water	10,000	do	New York Company.
Kearsarge district	Kearsarge Company	1866	20	Steam	50,000	do	Kearsarge Company.
Do	Kearsarge	1866	5	Water	15,000	do	Goldthwaite & Co.

Tabular statement of quartz mills in California, 1866—Continued.

Location of mill.	Name of mill.	When erected.	No. stamps.	No. arrastras.	Power.	Cost.	Gold, silver, or cement.	Occupants in 1866.
Lafayette, Owen's river	Union	1863	8		Steam	$15,000	Gold and silver	Union Mining Company.
Owen's lake	Owen's River Mill	1864	8		do	15,000	do	Owen's River Mining Company.
Owen's river, east side	New York Mining Company	1866	10	2	do	20,000	do	New York Mining Company.
San Carlos	Ida	1863	5		do	10,000	do	Ida Mining Company.
Do	San Carlos	1863	10		do	20,000	do	San Carlos Mining Company.
Slate range	Slate Range	1865	8		do	28,000	do	Slate Range Company.
KERN COUNTY.								
Erskine creek	Erskine Creek	1866		4	Water	5,000	Gold	Erskine Creek Company.
Greenhorn	Alpine Gold Mining Company	1866	24		Steam	30,000	do	W. F. White & Co.
Havilah	Agua Caliente	1865	10		do	16,000	do	Wolskill & Co.
Do	Freeman's	1864	4		do	6,000	do	New York and Clear Creek Mining Co.
Do	General Grant Gold Mining Co	1865	10		do	12,000	do	General Grant Mining Company.
Do	Howe & Oder's	1865	10		do	16,000	do	Howe & Co.
Do	Kellum & Wright	1866	10		do	10,000	do	Kellum & Wright.
Do	Loyala	1864	10		do	22,000	do	H. McKeadney.
Do	Marsh & Kennedy	1866	6	4	Water	17,000	do	Marsh & Kennedy.
Do	New York and Clear Creek Mining Co.	1866	10		Steam	22,600	do	New York and Clear Creek Mining Co.
Do	Pioneer	1865	8		do	9,000	do	J. H. Thomas.
Do	Rand & Co	1865	10		Steam	16,000	do	A. A. Rand & Co.
Do	Reed & Lillies	1865		2	Water	6,000	do	Reed & Lillie.
Do	Union	1865	12		Steam	18,000	do	J. H. Piper & Co.
Kelso cañon	Olanche Gold and Silver Mining Co	1866						Olanche Gold and Silver Mining Co.
Do	Pettus Gold and Silver Mining Co	1867		10	Steam	15,000	do	Pettus Gold and Silver Mining Co.
Do	Rogers's	1866	5		do	10,000	do	R. H. Rogers.
Kernville	Big Blue Gold and Silver Mining Co	1864	12		Water	40,000	do	Big Blue Gold and Silver Mining Co
Do	Sumner	1864	8		do	30,000	do	Kern River Gold & Silver Mining Co.
Keysville	Mammoth	1866	20		do	45,000	do	Mammoth Gold Mining Company.

Do.	Roberts & Co.	1855	4	1	do.	8,000	do.	G. D. Roberts & Co.
Posa Flat	Long Tom	1865	10		Steam	22,000	do.	Do.
Walker's basin	Joe Walker Mining Company	1866	20		do.	25,000	do.	Joe Walker Mining Company.
KLAMATH COUNTY.								
Black Bear gulch	Black Bear		12				Gold	Daggett, Coughlin & Co.
Eddy's gulch	Live Yankee		8				do.	William Coddington.
Do.	Union		8				do.	Henry Swain.
MARIPOSA COUNTY.								
Agua Frio creek	Mullen & Co.	1857	4	1	Water	2,000	Gold	Mullen & Co.
Bear creek	J. Boffio	1865	4	2	do.		do.	Juan Boffio.
Do.	G. Chittenden	1864	8	1	do.		do.	George Chittenden.
Bear valley	Bear Valley	1855	10	2	Steam		do.	Mariposa Company.
Boundurant	Hesleps	1866	10		do.		do.	Heslop & Co.
Do.	Shimer & Co.	1863	10		do.		do.	Shimer & Co.
Bridgeport	Washburn's	1865	15	1	do.		do.	Washburn & Co.
Buffalo gulch	Feliciana Vein	1865	5	3	do.		do.	L. Trabucco.
Bull creek	Black & Munn's	1860	4	2	Water		do.	Black & Munn.
Chimesal	Floyd's	1861	10		Steam		do.	J. D. Wilson.
Coulterville	Johnson's	1859	24		do.		do.	J. F. Johnson.
Gentry's gulch	Coward's	1860	10	2	do.	25,000	do.	H. G. Coward.
Hite's cove	Hite's	1863	8	4	Water	22,000	do.	J. Hite and Wynants.
Hornito's	Hornitos Gold and Silver Mining Co.	1860	20		Steam	30,000	do.	Hornitos Gold and Silver Mining Co.
Mariposa	Francis	1856	10	2	Water	4,000	do.	Charles Francis.
Do.	Mariposa	1864	50		Steam	82,000	do.	Mariposa Company.
Maxwell creek	Maxwell Gold and Silver Mining Co.	1864	40		do.	60,000	do.	Maxwell Gold and Silver Mining Co.
Merced river	Benton Mills	1858	64		Water	120,000	do.	Mariposa.
Do.	Ferguson's	1861	8	2	do.	6,000	do.	E. Ferguson.
Do.	Miller & Co.	1862	6		do.	5,000	do.	Miller & Jenkins.
Do.	Peck, Fountain & Co.	1862	6		do.	5,000	do.	Peck, Fountain & Co.
Do.	Rutherford Brothers	1860	8	2	do.	12,000	do.	James Tannerhill.
Mount Gaines	Mount Gaines	1862	10	2	Steam	13,000	do.	Felix Deville.
Mount Ophir	Mount Ophir	1858	24		do.	95,000	do.	Mariposa Company.
North fork Merced river	Clark, Derrick & Co.	1857	10		do.	7,000	do.	W. W. Kelton.
Do.	Goodman & Co.	1856	8	2	Water	4,000	do.	Goodman & Co.

Tabular statement of quartz mills in California, 1866—Continued.

Location of mill.	Name of mill.	When erected.	No. stamps.	No. arrastras.	Power.	Cost.	Gold, silver or cement.	Occupants in 1866.
Princeton	Princeton	1861	24	3	Steam	$40,000	Gold	Mariposa Company.
Sherlock's creek	Cashman & Co	1863	15		...do	20,000	...do	Cashman & Co.
Sweetwater	Ellis	1861	10	2	...do	6,000	...do	Samuel Ellis.
Do	Rollins & Co	1863	12		...do	8,000	...do	Rollins & Co.
Split Rock	Crown Lead Company	1863	40		...do	20,000	...do	Crown Lead Company.
Stockton creek	Mariposa	1858	8	2	Water	6,000	...do	Mariposa Company.
Temperance creek	Barrett's	1860	4		Steam	5,000	...do	Joseph Barrett.
Do	Lafayette Mining Company	1866	4		...do	5,000	...do	Lafayette Mining Company.
White's Flat	Daniel Breen & Co	1865	4	1	...do	1,500	...do	Daniel Breen & Co.
Whitlock's	Whitlock Gold and Silver Mining Co	1863	12	2	Water	22,000	...do	Whitlock Gold and Silver Min'ng Co.
MONO COUNTY.								
Bodie	Empire		16		Steam	130,000	Silver	Empire Mine and Mineral Company.
Do	Homestake		12		...do		...do	Homestake Mine and Mineral Co.
Hot springs	Williams & Wickland		4		Water	2,500	...do	Williams & Wickland.
NEVADA COUNTY.								
Bloomfield	Eureka Mining and Mineral Co		5	2			Gold	Eureka Mine and Mineral Company.
Cisco	Enterprise	1865		4	Steam		...do	Frank Maxon, superintendent.
French corral	American Mining Company	1865			Water	30,000	...do	J. S. Crall, superintendent.
Do	...do	1866	4		...do	7,000	Cement	Do.
Do	Empire	1865	10		...do	7,000	...do	B. Vilain, agent.
Grass valley	Allison's Ranch	1856	12		Steam		Gold	Stanton & Co.
Do	Alta Hill	1862	8		...do	22,000	...do	J. Jeffree, superintendent.
Do	Byers's	1865	4		Water		...do	John Byers.
Do	Cambridge	1866	10		Steam	30,000	...do	Cronise, Bulkley & Co.
Do	Eureka Mining Company	1864	20		...do	20,000	...do	William Watt, superintendent.
Do	Forest Spring	1857	10		Water		...do	J. H. Bayliss, superintendent.

Do	Gold Hill	1853	20		Steam	20,000	do	J. K. Edwards, superintendent.
Do	Hartery	1860	8		do	20,000	do	J. S. Lambert, superintendent.
Do	Ione Mining Company	1865	10		do		do	S. T. Curtis, superintendent.
Do	Lady Franklin	1856	8		do	10,000	do	J. R. Rush.
Do	Laramie's		8		Water	8,000	do	John Laramie.
Do	Laton's	1864	8	2	Steam	8,000	do	W. R. Taylor, superintendent.
Do	Lucky Mining Company	1866	15		do		do	Do.
Do	Merrimac	1864	10		do	13,000	do	H. Scadden, superintendent.
Do	Metallurgical Works	1862			do	3,000	do	William Hill.
Do	New Orleans	1863	8	2	do	15,000	do	John Smith, superintendent.
Do	North Star	1854	16		do	40,000	do	W. H. Bordela, superintendent.
Do	Ophir, New	1866	30		do	125,000	do	Empire Mining Company.
Do	Ophir, Old	1856	6		do	20,000	do	Do.
Do	Pacific Ore Company	1866	5		do		do	W. A. Williams, agent.
Do	Rocky Bar	1854	16	2	do	30,000	do	A. B. Brady, superintendent.
Do	Sebastopol	1863	12	4	do	20,000	do	Watt & Co.
Do	Town Talk	1864	8		do	10,000	do	J. Jeffree, superintendent.
Do	Union Hill	1866	20		do	20,000	do	Findley & Co.
Do	Wolf Creek	1863	5		Water	6,000	do	Joseph Perrin.
Do	Woodworth & Co	1865	15		Steam	30,000	do	Daniel McGrath, superintendent.
Hunt's Hill	Clay & Co	1866	8		Water	5,000	Cement	C. C. Going, superintendent.
Do	Eastern	1866	8		do	3,000	do	John Knox, superintendent.
Do	Gouge Eye	1866	8		do	3,000	do	Fuller, Goodspeed & Co.
Little York	Curran & Buckman's	1864	8		do	8,000	do	Curran & Buckman.
Do	Jenny Lind		8		do	3,000	do	F. Larkin.
Do	Remington & Pond's	1865	10		do	9,000	do	Remington & Pond.
Meadow lake	California Con. Mining & Mineral Co.	1865	8		Steam	17,000	Gold	J. K. Stewart, superintendent.
Do	Excelsior Mining and Mineral Co.	1866	20	*	do	75,000	do	James S. Harrison, superintendent.
Do	Grant Mining Company	1865	5		do	15,000	do	J. E. Squires, superintendent.
Do	Winton	1865	10		do	22,000	do	N. W. Winton & Co.
Nevada township	Banner	1866	10		do	15,000	do	George W. Kidd, superintendent.
Do	Cornish	1859	6	2	Water	8,000	do	Phil. Richards, superintendent.
Do	Empire	1866	10		do	4,000	Cement	Jacobs & Sargent.
Do	Federal Loan		2		Steam		Gold	J. Hecker, superintendent.
Do	Forest Hill	1861	5		do	8,000	do	E. Dunscombe, superintendent.

Tabular statement of quartz mills in California, 1866—Continued.

Location of mill.	Name of mill.	When erected.	No. stamps.	No. arrastras.	Power.	Cost.	Gold, silver, or cement.	Occupants in 1866.
Nevada township	French	1861	6	....	Steam and water	$24,000	Gold	L. Chauvonnat, superintendent.
Do	Gold Tunnel	......	6	....	Steam		...do	G. W. Kidd, superintendent.
Do	Green Mountain	1866	10	....	Water	7,000	Cement	Jacobs, Sargent & Co.
Do	Manzanita	......	15	....	Steam		Gold	W. Maltman, superintendent.
Do	Murchie's	1863	8	....	Water	5,000	...do	Murchie Brothers.
Do	Nevada Quartz Mining Company	1861	12	....	...do	25,000	...do	William Ratcliff, superintendent.
Do	Oriental	1854	8	....	Steam	10,000	...do	F. A. Miller, superintendent.
Do	Oro Fine	1860	6	....	Water	3,500	...do	Brown, Hinds & Co.
Do	Palmer's	1863	4	....	Steam	8,000	...do	O. Palmer.
Do	Pennsylvania	1864	8	....	...do	9,000	...do	J. H. Helm, superintendent.
Do	Province Gold and Silver Mining Co.	1864	12	....	...do	20,000	...do	Thos. F. Dingley, superintendent.
Do	Sneath & Clay's	1863	12	....	...do	65,000	...do	E. Dunscombe, superintendent.
Do	Stiles	1861	8	....	Water	5,000	...do	W. C. Stiles.
Do	Wigham	......	20	....	Steam		...do	S. D. Merchant.
Red Dog	Carney & Jackson	1866	8	......	Water	3,000	Cement	A. Tucker, superintendent.
Do	Weir & Garber's	1861	6	......	...do	2,500	...do	James Weir.
Do	Williams, Riggs & Co.	1864	12	....	Steam	15,000	...do	T. Riggs, superintendent.
Do	Wright & Co.	1865	10	....	Water	5,000	...do	Frank Ennis, superintendent.
Washington township	Brandy Flat Mining Company	......	4	....	...do		Gold	N. Knowlton, superintendent.
Do	Marietta Mining Company	......	5	....	...do		...do	Captain Lindsey, superintendent.
Do	Milton Willis Mining Company	......	4	....	...do		...do	S. D. Woolsey, superintendent.
Do	Star Quartz Mining Company	1863	8	....	Steam	15,000	...do	Edward Withington, agent.
Do	Tecumseh Mining Company	1864	8	....	Water	16,000	...do	John Patterson, superintendent.
You Bet	Brown Brothers & Co	1864	8	....	...do	6,500	Cement	H. K. Brown, agent.
Do	Cozzens & Garber's	1865	10	....	Steam	15,000	...do	Cozzens & Garbers.
Do	Heydlauff's	1865	10	....	Water	5,000	...do	W. F. Heydlauff, superintendent.
Do	Mallory & Co.	1866	8	....	...do	4,500	...do	S. Stelling, agent.

Do	Neece & West	1863	10		...do	6,000	...do	A. Neece, agent.
Do	Union	1865	10		...do	7,000	...do	Collins & Sons.
PLACER COUNTY.								
Auburn	Millett's	1866	5		Steam	3,000	Gold	—— Millett.
Bath	Paragon	1863	20		...do	15,000	Cement	J. Wheeler, agent.
Do	Rough Gold Company's	1865	10		...do	12,000	...do	William Davis, agent.
Colfax	Live Oak	1862	5		Water	4,000	Gold	John McKinney, agent.
Damascus	Pioneer	1855	6		Steam	12,000	...do	Colman & Co.
Devil's cañon	Missouri Company	1866	10		...do	12,000	Cement	A. Moore & Co.
Dutch Flat	McCullough	1866	5		...do	5,000	Gold	McCullough Mining Company.
Forest Hill	Baltimore	1866	10		...do	7,000	Cement	William Northwood.
Do	Big Spring Company	1866	10		...do	10,000	...do	J. P. Castner & Co.
Do	Hope Company	1866	20		...do	15,000	...do	George W. Reamer.
Do	Oro Company	1866	20		...do	12,000	...do	George W. Reamer, agent.
Gold Run	Indiana Hill	1865	10		Water	8,000	...do	A. H. Mallory, agent.
Harpending mine	Banker	1865	5		Steam	5,000	Gold	Harpending Mining Company.
Do	San Francisco Company	1866	40		...do		...do	Do.
Iowa Hill	Morning Star	1865	10		...do	10,000	Cement	James Dods & Co.
Newcastle	Schnabel's	1865	5		Water	2,000	Gold	—— Schnabel.
Ophirville	Pugh's	1863	5		...do	2,000	...do	C. D. Pugh & Co.
Do	Welty's	1865	10		Steam	6,000	...do	Welty & Co.
Sanders's ranch	Sander's Ranch Mill	1866	10		...do		...do	
Secret cañon	Secret Spring	1864	6		...do	10,000	...do	Grant & Co.
Stewart's Flat	Stewart's Flat	1864	5		...do	3,000	...do	J. Rogers.
Whiskey diggings		1866	10		...do	6,000	...do	
Do	Baker & Crosby	1866	40		...do	50,000	...do	Peachy, Hoffman & Co.
Wisconsin Hill	Oriental	1866	20		...do	25,000	...do	Conklin, Hosmer & Co.
Do	Arnold, Lee & Co	1866	10		...do		Cement	Arnold, Lee & Co.
PLUMAS COUNTY.								
Argentina	Sherman, Root & Co	1864		3	Water	1,500	Gold	Sherman, Root & Co.
Butte bar	Butte Bar Company	1864	4		...do	1,500	...do	Butte Bar Company.
Dixie	Abbott's	1863		2	...do	1,500	...do	H. B. Abbott.
Do	Compton's	1863	6		...do	6,000	...do	J. D. Compton.
Do	Dixie	1863	8		...do	7,000	...do	H. C. Bidwell.

Tabular statement of quartz mills in California, 1866—Continued.

Location of mill.	Name of mill.	When erected.	No. stamps.	No. arrastras.	Power.	Cost.	Gold, silver, or cement.	Occupants in 1866.
Dixie	Wiles	1863	6		Water	$5,000	Gold	Wiles & Brother.
Eureka lake	Eureka	1852	30	3	Steam and water	100,000	...do	John Parrott.
Franklin Hill	Franklin Hill Company	1860	6		Water	2,000	...do	Franklin Hill Company.
Genesee valley	Ward & Co	1862			...do	1,500	...do	Ward & Co.
Greenville	Greenville	1862	6		...do	6,000	...do	H. E. Bidwell.
Do	Lone Star	1862	8		...do	7,000	...do	Bidwell & Aschim.
Indian valley	Crescent	1862	24		Steam	25,000	...do	W. A. Bolinger & Co.
Do	...do	1866	32		...do	60,000	...do	Do.
Do	Indian Valley	1863	20		...do	20,000	...do	J. N. Blood & Co.
Do	Pennsylvania	1863	16		...do	20,000	...do	Trucks & Waterworth.
Jamison creek	Mammoth	1851	12	2	Water	20,000	...do	McGee & Thompson.
Do	'76 Company	1852		3	...do	3,000	...do	Elwell, Nave & Co.
Mohawk valley	King & Co	1866	4		...do	2,000	...do	King & Co.
Round valley	Golden Gate	1862	16	2	Steam	20,000	...do	Howell & Haynes.
Rush creek	Berg Mill	1863	8		...do	15,000	...do	Holthouse, Miller & Co.
SAN BERNARDINO COUNTY.								
Holcomb valley	Mellus	1860	4	4	Steam	20,000	Gold	A. Wade.
Maronga	Nichols	1864			...do	10,000	Silver	Maronga Mining Company.
Mojave	Green Lode	1863			...do	25,000	Gold and silver	George E. Moore.
SHASTA COUNTY.								
Copper City	Peck's	1864	8		Water	6,000	Gold	——— Peck.
French gulch	Highland	1863	10		Steam	10,000	...do	Thomas Purnell, superintendent
Do	Honeycomb	1865	8	2	Water	6,000	...do	S. Grover.
Do	Washington	1851	10		...do	10,000	...do	J. Syme, superintendent.
Lower springs	George's	1866			Steam	1,500	...do	W. H. George.
Do.	Union	1866	4		...do	4,000	...do	H. Jones.

Mulotown	Kanaka	1866	4		Water	3,000	do	—— Kelly.
Do	Potosi	1865	4		do	8,000	do	—— Catron.
Old diggings	Mammoth	1864	8		Steam	20,000	do	I. Isaacs.
SIERRA COUNTY.								
Alleghanytown	Eagle	1866	10		Steam	12,000	Gold	Eagle Quartz Mining Company.
Do	21 Quartz Mining Company	1865	4		Water	4,500	do	21 Quartz Mining Company.
American Hill	American Hill	1858	6		Steam and water	8,500	do	Young & Co.
Chipps	Rainbow	1857	8		Steam	8,500	do	P. A. Lamping.
Divide	Charcoal Company	1858	4		Water	8,300	do	Beauchamp & Langton.
Do	Keystone Quartz Mining Company	1858	12		Steam	12,500	do	Keystone Quartz Mining Company.
Downieville	Gold Bluff	1858	12	1	Water	14,100	do	Stumpf & Co.
Do	Montpelier Company	1858	8	1	do	7,000	do	Montpelier Quartz Mining Company.
Do	Oro Company	1860		2	do	6,000	do	P. A. Lamping.
Do	Slug Cañon	1859	4	1	do	7,100	do	Blackstone Quartz Mining Company.
Gold lake	Havens & Co	1860	8		do	5,150	do	Havens & Lemprich.
Gold valley	Gold Valley	1858	10		do	16,200	do	Herrick & Grey.
Hog cañon	Primrose Company	1858	12		Steam	15,400	do	Primrose Mining Company.
Jim Crow cañon	Ironsides	1864	8		Steam and water	10,600	do	Ironsides Quartz Mining Company.
Do	Plumbago	1862		1	Water	2,000	do	Hondley & Co.
Do	Sierra Consolidated	1863	12		Steam	60,000	do	Sierra Con. Quartz Mining Company.
Kanaka creek	Oak Flat Company	1863	4		Water	4,500	do	Oak Flat Quartz Mining Company.
Kanaka ravine	Kanaka Quartz Mining Company	1865	20		do	22,500	do	Kanaka Quartz Mining Company.
Middle Yuba river	French	1865	5		do	4,000	do	French Company.
Minnesota	Briggs & Co	1863	5		Steam	6,500	do	Briggs & Co.
Do	California	1855	4		Water	4,000	do	Wright & Bowen.
Mountain house	Mountain House	1858	4		Steam	5,350	eo	Watson & Co.
Sierra buttes	Bigelow Company	1858	4	2	do	6,000	do	Bigelow & Moore.
Do	Independence	1858	36	2	Water	36,000	do	Independence Mining Company.
Do	Kane & Co	1865		1	do	1,000	do	Kane & Co.
Do	Mexican Company	1858		2	do	1,000	do	Maldonado & Co.
Do	Sierra Buttes Company	1852	24	4	do	30,000	do	Sierra Buttes Company.
Web ravine	Union	1860	8		do	8,600	do	Union Quartz Mining Compnay.
Web ravine, M. F	Four Hills	1862	4		do	5,300	do	Spencer & Grey.
Web ravine, S. F	Chipps	1858	4	1	do	4,200	do	English & Higgins.
Web ravine, S. F	Kentucky	1856		1	do	5,000	do	—— McKenzie.

Tabular statement of quartz mills in California, 1866—Continued.

Location of mill.	Name of mill.	When erected.	No. stamps.	No. arrastras.	Power.	Cost.	Gold, silver, or cement.	Occupants in 1866.
SISKIYOU COUNTY.								
Humbug creek	Lash & Co.	1862	8	1	Steam	$6,000	Gold	Lash & Co.
Indian creek	London	1859	8		...do	10,000	...do	London Quartz Mining Company.
Do	Siskiyou	1859	8		...do	8,000	...do	
Quartz valley	Turk's	1857	4	1	Water	5,000	...do	F. Turk.
Siskiyou	Sleeper Mill	1863	8		Steam	5,000	...do	Sleeper & Co.
TULARE COUNTY.								
White river	Carter's	1866	8		Steam	20,000	Gold	J. Carter.
Do	Houston	1862	8	2	Water	8,000	...do	J. C. Birdseye.
Do	Hudnut	1866			...do	3,000	...do	Hudnut & Co.
Do	Josephine	1861	5	1	...do	5,000	...do	J. C. Birdseye.
TUOLUMNE COUNTY.								
American camp	Jones & Woodman	1864	10	1	Steam and water	10,000	Gold	Jones & Woodman.
Bald mountain	Sophia	1865	5		Water	5,000	...do	Josephi & Co.
Blue gulch	Eagle	1865	10		...do	10,000	...do	Eagle Mining Company.
Cherokee	Larco	1858	10	2	...do	3,000	...do	C. Lombardo.
Do	Magee	1859	8		Steam	7,000	...do	Platt Brothers.
Calder's ranch	Comstock	1864	10		...do	8,000	...do	Comstock & Fry.
Confidence district	Confidence	1858	10	3	...do	10,000	...do	T. Toulsly.
Do	Independence	1868	10	2	...do	10,000	...do	A. P. Brayton.
Deer creek	Deer Creek	1865	5		...do	8,000	...do	Deer Creek Company.
Five-mile creek	Hazel Dell	1864	5		Water	4,000	...do	Phelps & Co.

Do	Consuelo	1866	20		do	20, 000	do	Consuelo Company.
Do	Grizzly	1859	20		do	20, 000	do	Gashwiler & Co.
Do	Starr King	1866	5		Steam	7, 000	do	R. Inch & Co.
Poverty Hill	Golden Rule	1865	20		do	15, 000	do	Golden Rule Company.
Do	Heslep's	1860	10		do	10, 000	do	Heslep & Co.
Rawhide ranch	Rawhide Ranch	1866	20		do	45, 000	do	R. P. Johnson, agent.
Soulsbyville	Gilson's	1859	10	1	do	8, 000	do	Gilson & Hampton.
Do	Soulsby	1858	20		do	20, 000	do	D. Davidson & Co.
Sonora	Sonora	1866	15		Water	15, 000	do	Sonora Gold Company.
Sugar pine	Daegner	1864	10		Steam	10, 000	do	William Daegner.
Do	Eureka	1859	20		Water	20, 000	do	——— Edwards, agent.
Do	Excelsior	1860	10	1	do	10, 000	do	Wright & Gilmore.
Do	Green's		5		Steam		do	——— Green.
Do	Lombardo	1860	8		Water	10, 000	do	C. Lombardo.
Do	Monitor	1863	5	1	do	10, 000	do	Monitor Gold and Silver Mining Co.
Do	Pirate	1860	8		do	10, 000	do	C. Dorsey.
Summerville	Summers	1860	8		do	8, 000	do	G. Summers.
Summit pass	California Gold and Silver Mining Co.	1864	15	1	do	20, 000	do	Goddard & Co.
Stanislaus river	Telegraph	1860	20		do	20, 000	do	D. Davidson & Co.
Tuolumne river	Buchanan	1859	10		do	10, 000	do	Tuolumne Gold Mining Company.
Turnback creek	Laurel Hill	1857	10	2	do	3, 000	do	San Francisco Company.
Tuttletown	Patterson's	1857	10		do	10, 000	do	W. Patterson.
Do	Valparaiso	1858	10		do	6, 000	do	Valparaiso Company.
Whiskey Hill	Preston's	1860	10		do	4, 500	do	Rosecrans & Co.
Do	Reist's	1860	4		do	2, 000	do	C. Reist.
Whitman's pass	Whitman's	1866	5		do	5, 000	do	Milner & Co.
Wood's crossing	App's	1860	10		Steam and water	10, 000	do	John App & Co.
Do	Clem & Co	1859	9		Water	8, 000	do	Clem & Co.
Do	Duncan's	1859	4		do	3, 000	do	J. Duncan.
Yankee Hill	Shanghai	1862	10		do	10, 000	do	Gashwiler & Hooper.
Yorktown	Mrs. Hill's	1859	4		do	4, 000	do	Mrs. L. Hill.
YUBA COUNTY.								
Brown's valley	Danebroge	1859	8		Water	20, 000	Gold	Danebroge Mining Company.
Do	Jefferson	1862	12		do	40, 000	do	Jefferson Mining Company.

Tabular statement of quartz mills in California, 1866—Continued.

Location of mill.	Name of mill.	When erected.	No. stamps.	No. arrastras.	Power.	Cost.	Gold, silver, or cement.	Occupants in 1866.
Brown's valley	Pennsylvania	1862	16		do	$40,000	do	Pennsylvania Mining Company.
Do	Sweet Vengeance	1865	20		do	50,000	do	Sweet Vengeance Mining Company.
Eagleville		1865	8		do	15,000	do	Incorporated.
Indian ranch	Temple No. 2	1866	8		do	30,000	do	Do.
Middle Yuba	Mount Hope	1865	4		do	10,000	do	Mount Hope Mining Company.
Smartsville	Andrew Jackson	1866	10		do	12,000	do	Andrew Jackson Mining Company.

OREGON.

Gold placers have been worked in Jackson county, in the southern part of Oregon, since 1850, and the production has been estimated at $1,000,000 annually. The Secretary of State reports the yield of gold for 1864 as 106,226 ounces, valued at $1,900,000. The gold-washings of John Day river are reputed to have yielded $1,500,000 in 1866. The total production of the State for 1867 is stated to be $2,000,000 by some and $4,000,000 by others. These are partly estimates, and it is not possible to obtain exact and complete returns. I have adopted the estimate of $2,000,000 as probably nearest the truth. The shipments of bullion from Portland to San Francisco include the gold and silver from Idaho and a part of Washington Territory. The total amount of treasure manifested in 1866 was $8,726,017; but the sources from whence it came were not specified. There is a great want of authentic information upon the mineral resources of Oregon, which are believed to be very great.

In the Santiam district some promising veins have been opened and some very rich quartz extracted; but, for unexplained reasons, the mines are neglected and no returns of bullion have been made.

The following notices of these districts are condensed from a description furnished to the writer in 1866 by Mr. Foley:

Gold Creek district, North Santiam.—"The North Fork of the Santiam flows from the base of Mt. Jefferson (on the north side) west-southwest, through the western slope of the Cascade mountains, until it debouches in the main Santiam, 40 miles from its source. Gold creek heads on the south side of Web-foot mountain, (which divides the head-waters of Clackamas, Molalla, and Gold creek,) flows southwest 12 miles, and empties in the North Fork.

"Gold Creek district was organized on the 29th day of August, 1865. Its boundary is the area of country drained by the tributaries of Gold creek. Through the centre of this district runs north and south a backbone or mountain ridge, known as Web-foot ridge, having an altitude of 3,000 feet above the sea, which inclines or sloped to the east and west, at an angle of 35 degrees to the plane of the horizon, and is not more than 5,000 feet wide at its base, east and west. Twenty well-defined quartz lodes, already discovered, cross this ridge. Their general course is 25 degrees west or north, dip to the east-northeast from 20 to 35 degrees, and contain gold and silver. They are parallel and about 50 yards apart.

"Of these may be mentioned the Gibbs, Tracey, Jefferson, Moore, and Chapman lodes. The following named companies were organized for working in this district: Aurora, 7,200 feet; Oregon City, 10,000 feet; Laurel, 30,000 feet; Phœnix, 4,800 feet; Morning Star, 12,000 feet. The Aurora company has a tunnel 80 feet in length, from which has been taken about 150 tons of ore; the Oregon City, one of 40 feet, from which 70 tons has been taken; the Phœnix, a shaft 45 feet in depth. There is as yet no machinery in this district. Wood is abundant.

"South Santiam, or Santiam proper, is situated on the South Fork of

the Santiam. This stream flows from the south side of Mt. Jefferson. Some 30 quartz lodes are discovered in this camp, and they are similar to those of North Santiam, with the exception that they contain more copper ore. South and North Santiam are 40 miles apart as the quartz lodes run."

The number of stamp mills in the State in 1866 was 14, with an aggregate of 67 stamps and 17 arrastras.

Gold quartz mills in Oregon in 1866.

Location.	Name of mill.	When erected.	Number stamps.	Number arrastras.	Power.	Cost.	Occupants in 1866.
Baker county							
Baker City	Ruckles		20				J. S. Ruckles.
Grant county							
Prairie Diggings	Aldred & Co's			1	Water		Aldred & Co.
Vincent creek	Crowcher's		3		Water		Crowcher & Co.
Jackson county							
Applegate	Steamboat	1860	4	3	Water	$8,000	Fowler & Co.
Dardanelles	Occidental	1866	10	2	Steam	1,200	Hogan & Co.
Jackson creek	Hopkins	1860	5	1	Steam	8,000	Hopkins & Co.
Do	Johnson's	1862		2	Water	4,000	Johnson & Co.
Rogue river	Jewett's	1861	5		Steam	10,000	Byba & Co.
Sterling	Ives	1865		1	Horse	500	Porter Ives.
Thompson creek	Thompson Creek	1865		4	Water	1,500	Morris & Co.
Josephine county							
Enterprise	Enterprise	1865	10	2	Water	18,000	—— Cohen.
Union county							
Eagle creek	Eagle						Meacham Bros. & Co.
Hoquim	Carter & Davis	1865	5	1	Water	8,000	Carter & Davis.
Kooster	La Grande	1866	5			8,000	La Grande Co.

IDAHO AND WASHINGTON TERRITORIES.

Gold discoveries were first made in Washington Territory, on the eastern slope of the Cascade mountains, in 1858. The gold region was traced by miners along the Upper Columbia and its tributaries, and in 1860 the first gold discoveries were made in the Nez Percés mines, on the western slope of the Bitter Root mountains. The metal was also discovered upon the following streams: Salmon, John Day's, Powder, Grande Ronde, Burnt, Boise, Payette, Clearwater; all of them on the western slope of the Bitter Root mountains.[1] On the eastern slope Lieutenant Mullan and his party had found gold in 1853, but not in sufficient quantities to pay for working.

These mines are now within the limits of the Territory of Idaho, and the placers upon the Boise are considered the most important. Numerous valuable quartz mines have been opened, and in 1866 there were 32 quartz mills in the Territory, with an aggregate of 357 stamps, erected at a cost of nearly $1,500,000. It is estimated that the yield from the quartz mines amounted, in 1866, to $4,500,000, and from the placers, $1,265,000. In 1867, the yield, including silver, is reported as $6,500,000.

[1] See Mullan's Miners' and Travellers' Guide, p. 76.

These are the figures adopted by Commissioner Browne in his report for 1867, but intelligent residents of Idaho consider that this reported yield of gold and silver bullion is far too low, and estimate it as high as from $18,000,000 to $20,000,000, believing that large amounts are taken out of the Territory by miners without being manifested. The Hon. E. D. Holbrook, delegate of the Territory to Congress, estimates the total production as $20,000,000; gold bullion $16,500,000, and silver bullion $3,500,000. I cannot avoid the conclusion that these estimates are too high, and in the final tables of this report I have adopted the estimate of $6,500,000—gold $5,000,000 and silver $1,500,000—as the probable value of the production for 1867.

The following is an estimate of the total bullion production of Idaho for four years, to 1868:[1]

	1864.	1865.	1866.	1867.
Shipments	$6,223,000	$5,814,000	$5,443,000	$4,842,036
Add 10 per cent., the amount estimated to be shipped by other parties, and 10 per cent., the probable amount carried by private hands	1,244,600	1,162,800	1,086,600	968,406
	$7,467,600	$6,976,800	$6,529,600	$5,810,442
Deduct for Oregon and Washington, one-fifth	1,493,520	1,395,360	1,305,920	1,162,088
	$5,974,080	$5,581,440	$5,223,680	$4,648,354
Add for amounts probably taken out of Idaho by express, through Nevada and by private hands	500,000	1,000,000	2,800,000	1,352,000
Total	$6,474,080	$6,581,440	$8,023,680	$6,000,354

The gold of Idaho contains more silver than that of California, and averages about seven hundred and sixty thousandths, (.760.) There are gold washings in almost all parts of the Territory, even in the silver districts of Owyhee county, near the silver veins, where the gold bullion is worth about $9 per ounce. The Boise dust is worth from $15 to $18, and in some places as much as $19 per ounce. The gold of Florence is worth about $12 per ounce.

The celebrated Poorman lode is in the southern part of the Territory, and produces some gold, but this lode is noticed under the head of Silver.

The gold production of Washington Territory is reported to be $1,000,000, but is estimated by the surveyor general at $1,500,000.

MONTANA TERRITORY.

This Territory was organized and set off from Idaho in 1864. It includes the eastern slope or face of the Bitter Root mountains, and a part of the Pacific water-shed at the head of Clark's fork of the Columbia. Extensive placers and quartz veins are found in that section, and upon both sides of the Rocky mountain chain, at the sources of the Missouri river. The three principal centres of mining are, Bannock, Virginia, and Helena. Hot Springs, 28 miles northeast of Virginia, Summit, eight

[1] Mineral Resources of the United States, p. 535.

miles south, and Bannock, 75 miles northwest of Virginia, are the principal gold quartz-mining districts.

The number of stamp mills in operation in August, 1866, was 14, with an aggregate of 195 stamps.[1] The following is an estimate of the total production of the mines to 1868, made by James W. Taylor, esq., special commissioner for the collection of statistics upon gold and silver mining east of the Rocky mountains.[2]

1863	$2,000,000	1866	$12,000,000
1864	5,000,000	1867	12,000,000
1865	6,000,000		
Total to 1868			$37,000,000

A very interesting report upon the Mineral Resources of the Territory of Montana has recently been made by Mr. W. L. Keyes, mining engineer.[3] The area of the Territory is given as 146,689.35 square miles. In respect to the production of the precious metals, he observes: "We must premise any estimates by the statement of the peculiar difficulties of arriving at any conclusion susceptible of a demonstration. * * * The proportion of bullion produced by the vein mines has not, as yet, amounted to any considerable percentage of the gross yield, and hence does not call for a separate estimate. Another difficulty in the way of a precise statement of gold product is due to the fact that large quantities of dust can be, and doubtless have been, removed northwardly into the British possessions, of which no record is possible. Again, the distance of land transportation to Fort Benton, the head of navigation on the Missouri, is so trifling that merchants and miners act as their own transportation agents, and hence the precise amount carried away by them can never be ascertained. Montana's bullion account, at least until 1865, was largely credited to Washington, Idaho, or Colorado, and hence the tables, as reported by the United States mints, do not represent her true yield. I am indebted to the United States revenue collector for the following figures which form, in my judgment, a more reliable series of estimates for Montana than have ever been given to the public."

Gold product of Montana.

1862, chiefly from Bannock	$600,000
1863, chiefly from Bannock and Alder gulch	8,000,000
1864, Alder gulch, Bannock and other districts	16,000,000
1865, from near Helena, Confederate gulch, and Blackfoot	18,000,000
1866	17,500,000
1867	12,000,000
Total to 1868	$72,100,000

[1] Pacific Coast Directory.

[2] Reports upon the Mineral Resources of the United States, 1867, p. 329.

[3] "Mineral Resources of the Territory of Montana," in the volume of Reports on the Mineral Resources of the United States, 1868, p. 38.

A small portion of bullion from Montana finds its way to the San Francisco mint, $309,843 having been deposited there during 1867.

The surveyor general of Montana estimates the yield for 1867 at $20,000,000.

BRITISH COLUMBIA.

The gold producing belt of Oregon, Idaho, Montana, and Washington, is prolonged northward into British Columbia, and extends throughout its length, following the slopes of the Rocky mountain chain. Gold was first discovered in 1858, upon Fraser river, above New Westminster, and was traced by the miners to the Quesnelle river, 300 miles above, where gold is found upon both the south and the north forks, and beyond, in the region known as Cariboo. From Cariboo the miners penetrated some 450 miles further north and discovered gold placers upon Peace river, which flows eastward through the Rocky mountain chain and empties into the Mackenzie river through the Great Slave lake. The placers of the Stickeen are still further north, and were discovered in 1861. This river empties into the Pacific south of Sitka, near latitude 55°, and is navigable for small light-draught steamboats four months in a year, for about 150 miles from its mouth. Gold is found in the bars and high banks of the river above that point, but no very large quantity has been obtained. These placers are about 800 miles from Victoria, and in common with the Peace river, Cariboo, and other remote localities, are difficult of access, and can only be worked for a few months in the year, owing to the extreme severity of the winters. The channels of the streams are also very deep, so that it is almost impossible to reach the bed-rock by ordinary mining.

The aggregate yield of gold at Cariboo during the summer of 1861, of three of the principal creeks—Antler, Williams, and Lowhee—mined by from 90 to 100 men, was a little less than $1,000,000.

Of all these placers those in the valley of Fraser's river are the most important and productive. Considerable gold is also taken from the Kootenay mines, near the southern line, and adjoining Washington Territory.

The shipments of gold from Victoria to San Francisco, from 1858 to 1867, inclusive, were as follows:

1858	$337,765	1864	$2,784,226
1859	1,211,304	1685	2,067,661
1860	1,652,621	1866	1,625,311
1861	1,942,629	1867	1,100,588
1862	2,167,183		
1863	2,935,172	Total	$17,824,460

The shipments from July 1, 1865, to June 30, 1866, by the Bank of British Columbia and the Bank of British North America, were $2,054,205, to which should be added the product of the Kootenay region and the

bullion taken away by private hands. This would probably extend the amount to nearly $3,500,000.[1] The product for 1867 was probably not over $2,000,000.

NEVADA.

Nevada, although pre-eminently a silver producing State, has many districts containing promising auriferous veins, and about one-third in value of the production of the Comstock vein is in gold. Placer deposits were formerly worked in Gold cañon and American ravine, and are found in many of the small ravines west of Washoe valley, but the amount of gold produced from these sources is comparatively insignificant. Quartz veins bearing free gold are found in the Star mountain range, Humboldt, and in the first range east of it, in the region of Dunglen. They are found also in the region of East Walker river. The bullion produced at the mines near Aurora, Esmeralda county, is rich in gold, and at Bodie Bluff, in the vicinity, but within the limits of the State of California, there are many gold-bearing veins and placer deposits, which were formerly worked with considerable success. Still further south and east there is a gold-bearing region of veins and placers in the White mountain range, partly in California, which as yet has been but little explored.

In the Red Mountain or Silver Peak district, west and south of the White mountains, known for the large deposits of rich silver ores, there are also some enormous veins of quartz, bearing free gold, which is abundantly disseminated in small brilliant points, and gives promise of large and profitable returns when the veins are properly worked. A mill of 10 stamps has been erected near the vein, but no details of production have been given.

At Egan cañon, or Gold cañon district, 165 miles east of Austin, auriferous quartz veins are found, and a small mill was erected in 1864 which had great success, and a larger mill is to be constructed.

Gold is also reported to exist in some of the veins in the Santa Fé district, 18 miles from Austin; in the copper ores of Ravenswood district; and abundantly in veins in the New Pass district, about 25 miles west of Austin.

Some very coarse gold occurs in veins, with rich argentiferous copper glance, in Pahdet district, in the region of the White mountains.—(Specimen No. 63 of the California collection.)

In Desert district, along and near the route from the Truckee river to the Humboldt, there are some promising gold bearing veins, which have hardly been opened owing to the scarcity of water and distance from supplies. These veins are about 70 miles east of Virginia City.

The gold product of Nevada for 1867, including the gold in the bullion from the Comstock lode, may be estimated at $6,000,000.

[1] Pacific Coast Business Directory p. 157.

ARIZONA.

Gold localities appear to be very generally distributed over the Territory of Arizona, but Indian difficulties have greatly retarded explorations and the development of even the best known districts. The principal gold-mining centres are Wickenberg, Prescott, La Paz, Fort Mohave, and Gila City, upon the Gila river.

In the vicinity of the last-named place, and along the Colorado river, there are placer deposits of gold, which have been prospected and are known to be rich, but have never been profitably worked on account of the absence of water. Placers have also been worked upon Weaver's and Lynx creeks, in the interior.

The principal vein-mining region is within a circuit of 30 miles of Prescott, the capital. The veins are most numerous upon Lynx creek, east of Prescott, and among them may be named the Accidental, with a 2-stamp mill; the Eureka, the Eugenie, and Big Bug, the Ticonderoga, and the Green Tree, the four last upon what is known as Big Bug creek.

Vulture mine.—The Vulture lode, 15 miles east of Wickenberg, is now the principal mine of the Territory, and is energetically worked by a New York company. It was discovered in 1863 by Henry Wickenberg, who was enabled to open and prospect the lode by the proceeds of the rich rock taken out of it and worked in arrastras. The selected rock thus treated is said to have averaged $100 a ton for two years. The company which now owns the property has erected a 20-stamp steam mill, at a cost of $75,000, and expended $25,000 more in permanent improvements. The vein is about 19 feet wide, and rises in a bold outcrop which gives a large amount of surface ore, which is not yet half exhausted. A shaft has been sunk to a depth of 130 feet. The ore is a porous white quartz, with free gold in the cavities. Some galena is also found, and the indications are that in depth this galena will be much more abundant, and will perhaps enclose the gold, so as to render smelting necessary after concentration.

The mill has a capacity of 35 tons a day, and works about 200 tons a week. The production is nearly $1,000 per day, or $28,000 to $30,000 per month, or over $300,000 a year. The cost of labor and supplies is very great, partly on account of the Indian difficulties and the great distance from centres of supply. This mine was represented in the Exposition by specimen No. 213 of the California collection.

There are many veins in the region of La Paz upon the Colorado, and some near Williams's Fork, and the copper ores of both places contain gold as well as silver.

The bullion yield of Arizona for 1867 is estimated at $500,000.

NEW MEXICO.

The gold field of New Mexico has been known and worked since 1828. The portion so known is confined to the Placer or Gold mountains, about

20 miles from Santa Fé, towards Albuquerque. The yield of gold has been chiefly from placers, and was estimated by Wislizenus, in 1847, to vary from $30,000 to $250,000 a year, but it soon after diminished until it became comparatively insignificant. These placers are true hill deposits, affording coarse gold like that from the high placers of California. Owing to the absence of running streams there has been no opportunity to wash these deposits on a large scale. The gold which has been taken out was either obtained by "dry washing," or the earth was carted two miles to water to be washed.

Quartz veins are also found in the vicinity, and some shafts upon them are very ancient and the galleries extensive. The principal veins are the Ortiz and the Biggs. Gold also occurs in beds of quartzose sandstone, probably of the age of the Carboniferous, and has been worked to some extent in a mill erected by a Philadelphia company in 1857.[1]

Governor Arny, in his message to the legislature of the Territory, in December, 1866, mentions the discovery of lodes of gold-bearing quartz at Pinos Altos, and at San José, in the Sierra Madre, and near Fort Davis, in Texas. He also reports the existence of placers on the San Francisco and Mimbres rivers.[2]

The gold production of New Mexico for 1867 is estimated by Commissioner Browne at $500,000, but it probably does not exceed $300,000.

COLORADO.

The gold region of Colorado was represented in the Exposition by a large collection of the ores from the various districts, arranged under the direction of Mr. J. P. Whitney, the commissioner from the Territory. This collection filled two large cases, and was accompanied by a series of maps of the district and of photographs of some of the principal claims and mining towns. Mr. Whitney also published a pamphlet in English and French, descriptive of the Territory and its resources, with a list of the principal districts and claims.[3] A gold medal was awarded by the jury for this representation.

Gold was discovered upon the banks of the river Platte, near the present city of Denver, by some emigrants, in 1858. At that time there were very few white residents in the Territory, which now has a population of 36,000, exclusive of Mexicans and Indians. Denver, the capital, has a population of 7,000 to 8,000, and is situated upon the Platte, 12 miles from the foot of the mountains.

The counties of Bowlder, Gilpin, Clear Creek, Jefferson, and Summit, contain the principal gold localities. It is supposed, however, that other

[1] For further data by the writer upon these placers and the mineral resources of New Mexico, see Proc. Bost. Soc. Nat. His., vol. vii, p. 66.

[2] Cited in the report of J. W. Taylor, p. 325.

[3] Colorado in the United States of America. Schedule of ores contributed by sundry persons to the Paris Universal Exposition of 1867, With some Information about the Region and its Resources. By J. P. Whitney, of Boston, Mass., Commissioner from the Territory. London, 1867.

sections of the Territory contain gold-bearing veins, but no systematic explorations have been made. The principal mining has been in the counties of Gilpin and Clear Creek.

According to Mr. J. P. Whitney, from whose pamphlet most of this information is obtained, the gold veins traverse granite, and vary in width from a scarcely perceptible streak to 40 and even 50 feet, but seldom average over four or five feet.

The belts of country containing gold veins appear to have a uniform northeast and southwest course. In some districts the number of veins is very great, and they succeed each other with great regularity. In places they are so much broken and decomposed at the outcrops that the ground can be sluiced with profit.

The ores, as shown in the Exposition, are entirely different in appearance and composition from the ores of California. They are mainly composed of sulphuret of iron and copper, and quartz is hardly visible. The collection thus exhibited a brilliant metallic appearance, which was in strong contrast with the white auriferous quartz ores of California and other regions. Gold is rarely visible to the naked eye in these specimens, and can only be found by crushing and washing or by assay.

The presence of the veins is indicated on the surface by a light spongy quartz, discolored by the oxidation of the sulphurets, which also stain the soil by the deposition of oxide of iron. It is in these decomposed, rusted portions of the veins, between the surface and the water line, that the gold is free and in a condition to be separated from the ore by mechanical means. In the undecomposed or pyritous ore, which is found below the water in the veins, the case is quite different, the gold being so encased by the heavy pyrites that it cannot be wholly separated and amalgamated by stamping and washing in the usual manner, and it becomes necessary to resort to chemical means.

It is nevertheless the case that many mills are run upon this raw ore, and with fair returns, although probably a large part of the gold is lost. There are a few isolated instances where large profits have been made, but in such cases the ores doubtless were extremely rich. It is stated that during the present year (1867) the stamp mills have given an average of $24 per ton, but they have been supplied with the best ores.

Roasting in various ways has been tried with indifferent success, thus repeating the dear-bought experience of early quartz mining in California and the southern States, where it was early shown that roasting generally leaves the gold so coated or enfilmed that it will not readily amalgamate. The best practical results in Colorado have been obtained by smelting the ores so as to produce a matt which holds all the gold, silver, and copper, and is rich enough to bear transportation to Swansea, in Wales, for the separation of these metals. The presence of copper sulphurets in most of the ores renders this process more satisfactory and profitable, because the copper is utilized in the process at Swansea, and pays wholly or in part for the transportation. Some of the veins have

a preponderance of sulphuret of copper, and the assorted ores, in some instances, give from 20 to 30 per cent. of copper to the ton, and from $50 to $300 in gold. Ores which were sent, in 1866, to Swansea, yielded between $200 and $300 per ton, which, by the simple stamping and pan process, did not pay over $10 or $15 per ton. It is said that few of the veins contain less than from three to five per cent. of copper, and that this ore is usually the richest in gold.

Extensive smelting works have been erecting in Colorado the past summer for the production of matt upon a large scale, which is to be sent to Swansea for the extraction of the metals. The contents of the first matt obtained this year by the Swansea process was as follows per ton of matt: Copper, 37 per cent.; gold, 27 ounces; silver, 54 ounces. The works where this matt was produced have a capacity of seven tons a day only, and they are to be much enlarged.

In the review of Colorado mining processes and results, presented at the Exposition, it is stated that in the counties of Gilpin, Clear Creek, and Boulder, but chiefly in the two counties first named, there are 91 stamp mills, containing 1,698 stamps, varying in weight from 250 to 900 pounds each. There are, in addition, 41 other mills designed for Behr & Keith's, Crosby & Thompson's, Bertola's, Dodge's, Mason's, and processes other than mechanical; also smelting works at Black Hawk. Most of the mills are built of wood, and cost from $3,000 to $100,000 each. Most of them are driven by steam, some by water power.

The deepest shaft in 1866 was upon the Burroughs lode, in Nevada district, Gilpin county, which had attained a depth of 525 feet, and proved the existence of fine ore at that depth. Shafts have also been sunk upon the Gold Dirt, Bobtail, and the Gregory lodes to a depth of between 300 and 400 feet, with satisfactory results.

It is impossible to obtain accurate statistics of the amount of gold shipped from Colorado since the discovery. Mr. J. P. Whitney estimates it as not less than $30,000,000, and the production for the past year (1867) at $5,000,000. The official returns, however, do not show so high a yield, and it is stated at $2,500,000. The production from gulch diggings has been large, especially on the western side of the mountains.

The occurrence of washed gold in extremely thin scales has been cited by the writer as low down on the great plains as the old crossing of the Arkansas river, near Fort Atkinson. A sample of placer gold from this river, taken out higher up, yielded .971 by assay at the Dahlonega branch mint, in 1858, and was worth about $20 an ounce, nearly the same as the gold from the old and new placer in New Mexico.[1]

DAKOTA.

Accounts have recently been received of an extensive region of gold veins and placers in the region of the Sweetwater river, near the South

[1] Mineral Resources of New Mexico, W. P. Blake, Proc. Bost. Soc. Nat. Hist., vii, p. 64, July, 1859.

Pass. Large numbers of miners and prospectors were reported to be flocking there from Idaho, Montana, Nevada, and California. The Sweetwater mining region is divided into five mining districts: Shoshone, California, Mill, Pacific, and Kentucky Home. The Atlantic ledge in California district is more thoroughly prospected than any other. A shaft 70 feet deep has been sunk on the vein, and at that point it is said to be 20 feet wide. Good placers are reported and sluices have been laid in Atlantic Gulch. Timber and water are abundant. Rich placers are reported on the head-waters of Wind river and in the Big Horn mountains.

APPALACHIAN GOLD FIELD.

In the year 1799 Conrad Reed, a boy 12 years of age, picked up a piece of gold in the bed of a small stream on his father's farm in Cabarras county, North Carolina. It was not recognized as gold, and was kept for several years in the house to hold the door open, and was finally sold to a silversmith for $3 50. This mass was about as large as a small smoothing iron, and several other masses of large size were afterwards found in the same stream, the largest of all being the 28 pound lump, so often mentioned. There was no excitement in regard to gold until 1829, when placers were opened in Burke and McDowell counties, in the same State, and from these mines the gold was traced southward into Georgia, where it was first discovered on Duke's creek, in Habersham, now White county, in part. This discovery was made by a negro named Charles, when on his way from North Carolina to one of the towns in Georgia. From this discovery the metal was traced into Lumpkin county, and thence across Georgia into Alabama. A great rush for the newly discovered gold mines succeeded, and a large amount of gold was taken out of the beds of the streams and from the hill-deposits of gravel. This gold belt is a mountainous region; the deposits are very much like those of California, and many of them were astonishingly rich. The gold deposits were also traced northward into Virginia, and many valuable mines have been opened and worked there.

This gold field, which stretches southwesterly from Virginia through North Carolina, South Carolina, and Georgia, is not an unbroken or continuous zone of occurrence of the precious metals, but is composed of many subordinate belts, occurring at intervals, and generally parallel with each other, though often many miles distant. In North Carolina there are two principal belts, one of which extends across the State through Mecklenburg, Cabarus, Rowan, Davidson, and Guilford counties, and the other extends through Rutherford, Burke, and McDowell counties, and is from 10 to 20 miles distant from the base of the principal ranges of the Blue Ridge. This last is the most western of the two belts, and it is much more elevated than the first, and has more extensive and richer placer deposits. This is the belt of gold deposits which was traced into northern Georgia, and forms the gold region of the vicinity of

Dahlonega, and this region, as in North Carolina, is separated from another gold-producing zone by an intermediate barren region.

Quartz veins are found in both of these principal auriferous zones, and they closely resemble the quartz veins of California in appearance and in their contents. Gold is found either free, in coarse grains, or in fine particles, disseminated in sulphuret of iron or copper. Some of the veins which yielded gold freely at the outcrops, where the pyritous ore had decomposed, have been worked for copper ore in depth. One of the vein mines in North Carolina, the Gold Hill group, is said to have yielded over $2,000,000.

The deposits of gold from the Appalachian mines at the mint and its brances, between 1804 and July, 1867, are reported as follows:[1]

This is believed not to represent the entire production, for a very large amount was undoubtedly used in manufactures and did not reach the mints for coinage.

Virginia	$1,580,388 72	Alabama	202,172 13
North Carolina	9,344,933 29	Tennessee	81,406 75
South Carolina	1,354,864 52		$19,564,215 11
Georgia	7,000,439 70		

As the best placers were worked out the production rapidly diminished, and when the great discoveries in California were made known the placer deposits and many of the veins were abandoned for the new El Dorado. The most skilful of the miners in California at an early date were those who had already had some practical experience of mining in the southern States. The following table, showing the amount of gold from Georgia deposited at the Philadelphia mint and Dahlonega branch mint up to the close of the year 1855, will show the rapid decrease in the production:

1828 to 1837	$1,763,000	1852	$96,542
1838 to 1847	3,514,669	1853	58,896
1848	254,746	1854	54,588
1849	236,349	1855	58,419
1850	209,587		$6,434,909
1851	157,213		

The quality of the gold from the different placers and veins along the gold field varies considerably, as it does in California and other gold fields. The average quality of Georgia gold is, however, rather above that of California, as is shown by the following averages of a great number of assays of the bullion from the principal stream deposits and vein mines of Georgia:

Auraria, Lumpkin county, vein and placers	.950
Dahlonega, Lumpkin county, vein	.925
Lewis mine, Lumpkin county, vein	.899
Calhoun vein, Lumpkin county, vein	.900

[1] Report of the Superintendent of the United States Mint.

New York vein, Lumpkin county, vein	.900
Loud deposit, Lumpkin county, placer	.880
Loud deposit, Lumpkin county, placer	.830
Asbury and Craigs, Lumpkin county, placer, (near Loud Deposit)	.819
Pasco mine, Cherokee county, vein	.950
Bell mines, Cherokee county, vein	.975
Stricklan, Cherokee county, vein	.950
Elrod, Hall county, vein	.906

If we leave out the assays of gold from the Loud deposit, which is peculiar for its amount of silver, the average of all becomes 928 thousandths. California gold is usually estimated at 875 to 900 thousandths fine.

In the State of New Hampshire gold has been found in alluvial deposits of limited extent on the flank of the Green mountains, and some of the placers have been worked with fair success by individuals, but the total production is insignificant compared with other regions. Within the past three or four years some attention has been given to veins of gold-bearing quartz in that section. Neither these mines nor those of the southern States were represented in the Exhibition.

CANADA.

The Geological Commission of Canada exhibited gold from the alluvial deposits of the valley of the Chaudière river.

This gold appears to be derived from the degradation of the metamorphic rocks of the Upper Silurian and the Devonian periods. These rocks are found to be traversed by numerous veins which carry sulphurets of iron, zinc, copper and molybdenum, and argentiferous galena with native gold. The alluvial deposits derived from the abrasion of these veins and the enclosing rocks cover a great extent of country to the southeast of the Notre Dame mountains, and are found to be auriferous. This placer or alluvial gold is sometimes accompanied by a little platina and iridosmine.

Mining in the region has been confined chiefly to the alluvial deposits, and it has been attended with considerable success in some places. One of the most productive and extensive deposits is upon the Gilbert river, on the De Lery grant. The gold is quite coarse and heavy.

NOVA SCOTIA.

The Gold Commission of Nova Scotia exhibited a collection of gold nuggets and of auriferous quartz from the various gold fields of the province. Other collections of minerals and ores were sent by Mr. H. How.

Among the most prominent or interesting specimens the following may be noticed:

Gold in quartz from Hamilton, Tangiers. This gold is remarkable for

its purity and rich yellow color. Similar specimens were shown from Oldham, containing also iron pyrites and mispickel, with which the gold is closely associated. The walls of this vein appear to be a black graphitic slate similar to that of the Hayward mine in Amador county, California, and at the Princeton vein on the Mariposa estate. There was, also, an interesting series of specimens from Renfrew, Isaac's Harbor, and Montagu. These ores occur in the Lower Carboniferous conglomerate of Gray's river.

One of the most remarkable deposits of quartz yet found in Nova Scotia is on Laidlaw's farm, Waverly. It is in a horizontal bed from eight to ten inches thick, and is corrugated to such a degree that where uncovered it looks like a layer of logs or trees side by side, as they are placed in making corduroy roads. It also resembles an assemblage of small casks placed end to end, and from this circumstance the miners have given the name "barrel quartz" to the formation. The general course of the quartz veins is north 60° west, and their dip is toward the southwest. The gold was first discovered at the head-waters of the Tangier river, and other localities were soon discovered in succession at the Ovens, Lunenberg; at Lawrencetown, Dartmouth, Sheet Harbor, Isaac's Harbor, Sherbrooke, Waverly, and Oldham.

A report upon the gold region of Nova Scotia has recently been made by Dr. T. Sterry Hunt, F. R. S., and addressed to Sir W. E. Logan, director of the geological survey of Canada,[1] to which reference may be made for full details of the geology and of the present condition of the mines. A few extracts are here given:

"Although the Acadian Geology of Dr. Dawson was published in 1855,[2] some years before the discovery of gold, there will be found in its fifteenth chapter a somewhat detailed description of the coast district of Nova Scotia, which has since become famous as a gold region. This consists of a zone of ancient stratified rocks lying exposed between the overlying strata of the Carboniferous system on the northwest and the ocean on the southeast, and having a breadth of from 30 to 50 miles in the wider portions, which to the northeast is reduced to not over eight miles. This belt of rocks extends along the Atlantic coast for a distance of about 250 miles, from Cape Sable on the west to Cape Canseau on the east, and has a superficies of about 6,000 square miles. Its surface is generally low, rising, however, in some places, to about 500 feet above the sea, and is in great part rocky and barren, the powerful denuding agencies to which, in past times, it has been exposed, having, over a large portion of the area, removed the alluvial deposits with which it was once covered and left the upturned and worn edges of the strata bare, or covered only with boulders of quartzite or granitic rocks. A large portion of this region is still an unexplored wilderness, and some of the most important gold districts are in localities which, until the discovery of the

[1] Printed by order of the House of Commons, Ottawa, 1868.

[2] A second and much enlarged edition of this work is now in press, and will shortly appear

precious metal, were unreclaimed forests, so that it is in every way probable that further explorations may detect many other districts not less important than those already known.

"The rocks of this region consist chiefly of slates and quartzites; they are, however, cut in many places by intrusive granites, and in addition to these several small areas of gneissic rocks occur in different parts of the belt, but their true relations to the great mass of the strata are not yet clearly made out. Leaving these aside, the rocks which cover the principal part of the area under consideration are, by Mr. Campbell, divided into a quartzite group and a clay-slate group, the latter conformably overlying the quartzite, and the two constituting one gold-bearing series. The total measured thickness of these two divisions is, according to the same authority, nearly two miles; but the gold appears to be chiefly confined to the quartzite, and the lower portions of the clay-slate division. The geological age of these rocks is uncertain; although comparatively little altered, they are without fossils, so far as yet known, and are very unlike the fossiliferous Upper Silurian and Devonian rocks met with in other parts of the province; at the same time the high antiquity of the gold-bearing strata is shown by the fact that the Carboniferous system rests upon their upturned edges, and is partly formed from their ruins. In the present state of our knowledge it appears probable that they may represent a part of the Lower Silurian series, which, like the Upper Silurian and Devonian of this part of the continent, may be supposed to consist chiefly of non-calcareous sediments.

"The rocks of the gold series are affected by undulations running nearly east and west, which have raised the strata to high angles, often approaching the vertical. According to Mr. Campbell there are not less than six principal anticlinals exhibited on a transverse line of section, extending from the sea-shore at the southeast entrance to Halifax harbor, northward to the Renfrew gold district, a distance of about 35 miles. The direction of these nearly parallel anticlinals is about east and west; but to the westward they bend towards the south, and to the eastward, in like manner, disappear beneath the sea, between Cape Canseau and Liscombe harbor, with a strike east 30° south.

"In addition to the great east and west folds the gold series is affected by a second series of more gentle undulations, having a north and south direction, and producing transverse anticlinals, on the crowns of which the gold-bearing portions of the series are brought to the surface, while they are concealed not only in the great east and west synclinals, but also in the north and south synclinals where these traverse the east and west anticlinals. The total thickness of the series, as already stated, is estimated at about two miles, and the amount of erosion on the crowns of some of the anticlinals, according to Mr. Campbell, cannot be less than one and a half mile in vertical thickness, of which the upper half mile, consisting of clay-slates, is generally sterile. Since, so far as yet observed, the gold is confined to the quartzite and the lowest portions of the over-

lying clay-slate, it would follow that wide areas of the latter, holding the upper portions of it, will be destitute of gold, or yield it only along a narrow belt where the lower and auriferous portions of the slate may be brought to the surface along the line of an anticlinal, as is observed, according to Mr. C., at the Ovens gold field. When, on the contrary, erosion has exposed a wide zone of the underlying quartzite on the crest of an anticlinal, the breadth of the area in which gold may be sought for is much increased.

"Mr. Campbell has called special attention to what he has called the grain or reed-like marking often impressed on the surface of the beds in a direction parallel to the east and west axes of folding, and he points out that the angle of dip, eastward or westward, of these markings on the crown of the great anticlinals enables us to detect the transverse or north and south lines of undulation, which have at a subsequent period disturbed the horizontality of the east and west anticlinal folds. The markings in question often appear as rib-like ridges or flutings, which are most conspicuous on the surface of the auriferous quartz layers and the enclosing beds. On the summit of the anticlinal folds they are sometimes so large and so well defined as to give to the layers a wrinkled or corrugated form, producing what is designated in the region as barrel quartz, and has by some observers been compared to the ripples on water, and by others to that parallel arrangement of logs which is seen on what is called a corduroy road. The best known sample of this is at Waverly, but it is also seen at Montague, Oldham, and at Upper Stewiacke.

"Having thus acquired a general notion of the geological structure of the region, we may consider its lithological characters, which are very simple. The quartzite which forms the principal rock of the lower division, interstratified however with thin layers of bluish argillite or clay-slate, is essentially a granular quartz rock, with an apparently argillaceous cement, sometimes considerable in amount. It is hard and gray in color, passing into blackish or greenish in the interior, but becoming nearly white on weathered surfaces. Its lines of bedding are distinct, and besides two sets of joints which often cause it to break into regular rhombic masses, it occasionally shows a slaty cleavage, independent of the bedding, and from a development of mica in the cleavage planes, passes into a very quartzose mica slate. The quartzite of this region is by the miners generally designated as *whin*, the vulgar name in Scotland for a greenstone or diorite, which somewhat resembles it in color and texture, though a softer rock than the Nova Scotia quartzite.

"The slate, which is interstratified in thin bands with the quartzites, and frequently forms the underlying rock of the gold-bearing quartz lodes, is generally a soft and fissile, bluish or blackish argillite, or clay-slate, and the same may be said of the strata which forms the base of the upper or clay slate division of the gold series, so far as I have had an opportunity of observing it. A peculiarity of this region, which strikes every mineralogist, is the great rarity of everything like calcareous rocks

or minerals. This is seen in the absence of limestone, serpentine, diorite, or other hornblendic rocks, and of talcose or chloritic slates, nothing of the kind being met with in most of the gold districts. Professor Silliman, however, mentions the rare occurrence of chloritic slate, and also of epidote and staurotide in minute crystals in the Tangier district, and of a green magnesian rock resembling serpentine and holding gold, at Wine harbor. Small portions of chlorite are found in the quartz lodes at Sherbrook, Oldham, and Montague. Chloritic and hornblendic rocks, according to Dr. Dawson, occur near Yarmouth, and in the peninsula which terminates in Cape Canseau, fine-grained gneiss with much mica slate, and clay-slates abounding in crystals of chiastolite, are met with."

METALLIFEROUS LODES.

"In the series of rocks just described gold is occasionally met with disseminated both in the quartzite and in its accompanying bands of slate; but it is chiefly found in well-defined beds or layers of a more or less pure quartz, which are generally very distinct from these rocks, although interstratified with them. Besides these there are other quartz lodes which cut or intersect the strata, filling cross fissures, which, according to Mr. Campbell, are generally connected with the north and south lines of elevation. These cross veins are irregular, seldom continuous, and, though sometimes carrying gold, are of little economic importance and seldom wrought. The fact that the productive quartz lodes of Nova Scotia are conformable with the stratification has been insisted upon both by Messrs. Silliman and Campbell. The latter, who conceives them to be newer than the strata, and to have been formed in openings or separations between the beds of slate and quartzite, mentions that the lodes in some instances pass from the plane of one bed to another, in descending. In one supposed instance pointed out to me, this appearance seemed due to a small fault running east and west, parallel with and near the crown of a great anticlinal. In other cases this apparent change of plane depends, I think, upon irregularities in the bedding, and the intercalation of lenticular masses of argilite or quartzite in the layers of metalliferous quartz. The beds of all these materials occasionally thin out and disappear in the strike or dip, and in some cases beds of quartz, separated by layers of interposed rock, are found to unite, further on, into a single bed. So far as my present observation goes, I think that to describe them otherwise than as interstratified beds would be to give a false notion of their geognostic relations. The laminated structure of many of the lodes, and the intercalation between their layers of thin continuous films or layers of argillite, can hardly be explained in any other way than by supposing these lodes to have been formed by successive deposition at what was, at the time, the surface of the earth. There is, moreover, evidence that these laminæ were formed before the lodes were folded and contorted; this is furnished by some remarkable specimens of the so-called barrel quartz which I took from a lode at Upper Stewiacke, and which

consists of a bluish quartz in thin plates, sometimes not more than one-twentieth of an inch in thickness, and presenting in some instances glazed surfaces coated with thin argillaceous films, and in others, pellicles of argillite having the thickness of paper. The surfaces of all these layers are deeply striated or furrowed at right angles to the axis of the larger convolutions of the bed, a result evidently due to a sliding of the layers of the quartz lode over one another during the corrugation of the strata, which has here taken place near the summit of the anticlinal. It seems not improbable that the corrugated structure of the lodes, which gives rise to the barrel quartz, is due to the difference in texture, and to the greater resistance to lateral pressure offered by the quartz layers than by the enclosing beds of clay and sandstone, which by their consolidation have given rise to the argillites and quartzites. There is, moreover, evidence that during the movement of the strata openings and fissures were in some cases formed in these quartz lodes, giving rise to joints in which gold, metallic sulphurets, and carbonate of lime were afterwards deposited, apparently by solution and segregation from the adjacent parts of the lode."

GOLD PRODUCTION OF NOVA SCOTIA.

A gilded pyramid in the Exposition represented the bulk of the gold extracted from the Nova Scotia mines from January, 1862, to the month of September, 1866, according to the official reports. This pyramid was about five feet high and 18 inches square at the base. The total weight of the gold so represented was stated to be 2,634 kilograms and 393 gramms; its value 8,161,579 francs, or about $1,632,315.

The following are the official returns of gold obtained from Nova Scotia, from 1860 to 1866:

Production from 1860 *to* 1866.

Period.	Average No. of men employed.	No. crushing mills.	Steam power.	Water power.	Quartz, sand, & gravel crushed.			Yield per ton.			Gold from alluvial mines.			Total yield of gold.		
					Tons.	*cwt.*	*lbs*	*Oz.*	*dwt.*	*gr.*	*Oz.*	*dwt.*	*gr.*	*Oz.*	*dwt.*	*gr.*
Year ending December 31, 1862	484	30	18	12	6,401	0	0	1	1	1	311	0	0	7,275	0	0
Year ending December 31, 1863	877	35	25	10	17,001	11	15	0	16	12	28	0	0	14,001	14	17
Nine months ending September 30, 1864	830	35	23	12	15,316	14	0	0	10	0	38	11	3	14,565	2	8
Year ending 1865	692	33	24	10	23,835	11	0	1	0	21	141	0	7	24,867	5	22
Total	.....	.....			62,551	19	15	.....			.....			60,709	9	23

The statistics of production are given by Mr. Taylor[1] in dollars as follows:

1862	\$145,500	1864	\$400,440
1863	280,020	1865	509,080

He further states that the statistics exhibit very accurately the average yield per man, which in 1863 was 95 cents a day; in 1864, \$1 39; and in 1865, \$2 13. The ingots or bars of Nova Scotia gold are current in Halifax at \$20 per ounce. The assays made by Professor Silliman show values of \$19 97 and \$20 25. The gold commissioner of Nova Scotia assumes \$19 50 per ounce as the basis of his calculations of the value of the gold product of the province.

A table from the report of the chief commissioner of mines, showing the returns of the gold mines of Nova Scotia for the year ending September 30, 1867, is given on the next page. In this table are given for each gold district the average daily labor employed, the number of mills with steam or water power, the number of tons of quartz crushed, the average yield of gold to the ton, the quantities of alluvial gold, the total amount of gold, and finally, the annual return for each miner employed, the price of gold being estimated at \$18 50 the ounce, which, as we have seen, is considerably below the real value. A column giving the maximum yield per ton from each district has been omitted, inasmuch as it is deduced from the treatment of lots of ore of exceptional richness. Dr. Hunt says:

"It is impossible to determine with precision the total amount of gold obtained from the mines of Nova Scotia since their discovery. The Department of Mines was not organized until 1862, and it was not until the following year that complete returns were obtained. From this it results that no accurate estimate can be given of the amounts of gold obtained in 1860, 1861, and 1862, though they are supposed to have been not inconsiderable. The official returns for the last six years, based on the gold for which the royalty of three per cent. has been paid, are as follows:

	Ounces.
1862	7,275
1863	14,001¾
1864	20,023
1865	25,454¼
1866	25,204½
1867	27,583
Total	119,541½

"The value of the above amount of gold, at the government price of \$18 50 the ounce, is \$2,211,508; but at \$20, which is about the worth of

[1] Report of J. W. Taylor, p. 337.

the Nova Scotia gold, it amounts to $2,390,081. If to this we add the unreported gold obtained in the first two or three years, we may conclude that the whole product has been equal in round numbers to about two and a half millions of dollars."

The following is a detailed statement showing the average daily labor employed, the amount of quartz crushed, the yield of gold per ton of quartz, the quantities of gold from alluvial mines, the yield of gold per ton in each district and in the whole province, and the value of the average yield of gold per man employed in mining, for 12 months ending September 30, 1867:[1]

Production of the mining districts for one year.

Districts.	Average men employed.	Crushing mills employed September 30, 1867.	Steam power.	Water power.	Tons of quartz, &c., crushed.	Yield per ton.	Alluvial gold.	Total yield of gold.	Average yield per man for 12 months at $18 50 per ounce.
						oz. dwt. gr.	oz. dwt. gr.	oz. dwt. gr.	
Stormont, (Isaac's Harbor)	45	2	2	....	1,149	1 5 8	....	1,505 2 11	$618 73
Wine Harbor	33	4	3	1	1,667	8 13	....	764 9 9	428 60
Sherbrooke	99	5	5	....	5,809	1 9 8	....	8,522 8 11	1,582 58
Tangier	19	4	2	2	486	16 7	20 6 0	395 16 10	365 56
Montague	19	1	1	....	214	1 19 0	....	417 13 22	[illegible]
Waverley	181	5	4	1	11,280	7 7	....	4,134 18 17	422 63
Oldham	52	4	3	1	960	1 8 7	....	1,359 12 2	[illegible]
Renfrew	189	5	3	2	7,770	1 4 4	....	9,401 2 10	[illegible]
Uniacke	30	3	3	....	1,222	15 15	....	947 1 17	[illegible]
Unproclaimed, and other districts	9	2	1	1	117	1 3 4	28 15 15	135 0 21	278 55
	676	35	27	8	30,673	17 23	49 1 15	27,583 [illegible]	[illegible]

MEXICO.

Most of the gold produced in Mexico is found associated with the ores of silver. The average annual production in the present century, according to the mint returns, has ranged from $500,000 to $1,300,000. It is believed, however, that only about three eighths of the total product of gold passes through the mints. Upon this hypothesis Mr. Danson calculates that the total production of gold in Mexico, from 1804 to 1847, was nearly $85,000,000.[2] Duport estimated the value of the gold mined in Mexico as about one eighth that of the silver, and its weight, including the gold separated from silver, as $\frac{1}{13}$ of that of the silver.

[1] From the report for 1867 of Hon. Robert Robertson, chief commissioner of mines for Nova Scotia, appendix B.

[2] Vide Chapter V, under "Silver," and Jour. Stat. Soc., Lon., xiv.

PRODUCTION OF GOLD AND SILVER IN THE UNITED STATES AND TERRITORIES.

PRODUCTION IN THE YEAR 1867.

The following tabular statement of the value of the total production of the precious metals in the United States and Territories for the year 1867 is prepared from the data given in the foregoing pages. The figures are in round numbers; they are in part estimates, and are to be regarded as close approximations, it being impossible to obtain the *exact* amounts. The data show that the value of the total production for the year is \$71,000,000. Of this, \$56,000,000 is considered to be in gold bullion, and \$14,500,000 is silver, this being exclusive of the value of the gold in the bullion from the Comstock lode. One-third of the value of the Comstock bullion, and a little over one-fifth of the value of the Idaho production is regarded as gold. The aggregate value of the gold and silver bullion is given in the last column. The estimated value of the silver bullion is given in the second column, and the value of the gold bullion is obtained by subtracting the value of the silver from the total value. As the returns of production of gold and silver are not separately made, it is not possible to segregate the exact value of each, and only estimates can be given.

One-third of the value of the Comstock bullion and a little over one-fifth of the value of the Idaho production is regarded as gold.

Bullion production of the United States and Territories in 1867.

States and Territories.	Value of gold bullion.	Value of silver bullion.	Total value of bullion.
California	\$25,000,000	....	\$25,000,000
Nevada	6,000,000	\$12,500,000	18,500,000
Oregon and Washington	3,000,000	....	3,000,000
Idaho	5.000,000	1,500,000	6,500,000
Montana	12,000,000	....	12,000,000
Arizona	500,000	....	500,000
New Mexico	300,000	....	300,000
Colorado	2,000,000	500,000	2,500,000
Utah, Appalachian, and other sources not manifested	2,700,000	....	2,700,000
Totals	\$56,500,000	\$14,500,000	\$71,000,000

This, it will be seen, differs from the estimate made by Commissioner Browne in the report upon the mineral resources of the United States for 1867. He considers \$75,000,000 to be a near approximation to the total gold and silver product of the United States for the year ending January 1, 1868. He places the product of Nevada at \$20,000,000, and makes an allowance of \$5,000,000 to cover bullion derived from unknown sources, and unaccounted for by assessors and express companies.

There is room for a wide difference of opinion in regard to the production of gold in remote sections of the Pacific coast whence the bullion reaches San Francisco through a variety of channels; but it is believed

that the only safe guides for estimates of the yield are the regularly reported shipments by the express companies and the records of exports from San Francisco.

In regard to the difficulty of collecting statistics of mining and of the bullion product of the United States, Commissioner Browne makes the following just observations:

"There is no subject upon which greater difference of opinion exists than that of mining statistics. It is an open field in which there is room for discrepancy under any existing circumstances. No two persons rate the product of the precious metals alike. The superintendent of a mine often furnishes information which, when submitted to the board of directors, is pronounced incorrect. Representatives from the mining districts are apt to rate both population and products higher than persons who have made them special subjects of inquiry, but whose opportunities for judging may not be so favorable.

"A fruitful source of error is in supposing that the ordinary channels of transportation cannot be relied upon as a clue to the gross products of the mines. It is alleged that large quantities of the precious metals are carried away in the pockets of the miners. Even if this were so, it is not reasonable to suppose that the miners continue to burden themselves with their treasure after arriving at their place of destination. It must find its way into the mint or branch mints for coinage, or the custom-house manifests for exportation. It cannot be assayed without paying its internal revenue tax. The gross yield of all the mines can be determined with approximate accuracy. It is more difficult to arrive at a subdivision when it comes to the product of each State and Territory.

"In California, for example, during the early days of placer mining, before the transportation of bullion by organized companies had become a business entitled to confidence, a large proportion of the gold derived from the mines was carried out of the country by private hands. There was comparatively little danger of loss. The routes to San Francisco were short, public, and protected by general interest. From that point to New York the passengers usually combined for mutual protection, and the risk was inconsiderable. It was not until the idle and profligate began to obtain an ascendancy, the business of transportation by express more firmly established, and the mines more difficult to work with profit, that the increase of risks and reduction of charges resulted in the general abandonment of this system. It doubtless prevails to a limited extent now, but the transportation of bullion by private hand in California is exceptional. It probably does not exceed seven per cent. in the aggregate, and this applies only to the routes by which it reaches San Francisco.

"In reference to silver, it is impossible that any considerable amount can escape notice in this way. The yield of Nevada can be determined with more accuracy than that of other States. Silver predominates in the mines, and where gold is obtained it is not in an uncombined form.

"When we come to Montana, Idaho, Washington, and Oregon, the

greatest difficulty is experienced. Shipments of treasure from Montana and Idaho may become incorporated with others before reaching their destination. From Montana most of the bullion goes east. Two main routes are open to examination—one by the Missouri river, the other by Salt Lake City. Indian disturbances and the insecurity of the roads have, during the past year, almost entirely closed the latter, so that the chief exit is by the former route. Shipments from Idaho are made chiefly by way of Portland, and the inland stage-route through Humboldt and across the Sierra Nevadas. On both of these routes it is alleged that they are liable to become merged with the products of other States and Territories. It has been impossible to obtain an account of the shipments from each agency at the express office of Wells, Fargo & Co., at San Francisco For reasons of private expediency they refrain from giving the desired information. We have, however, the aggregate receipts at their office, and knowing very nearly what amount can fairly be credited to California, Nevada, and British Columbia, can draw reasonable conclusions as to the proportion derived from Idaho, Washington and Oregon.

"The bullion product of Washington is estimated by the surveyor general at $1,500,000. That of Oregon is stated as high as $2,500,000. Intelligent residents at Idaho and Montana represent that the figures given in the above estimate, so far as these Territories are concerned, are entirely too low, and might be doubled without exceeding the truth. The product of Idaho alone, for this year, is said to be from $15,000,000 to $18,000,000. That of Montana is estimated by the surveyor general at $20,000,000. Similar exceptions are taken to the estimates of Colorado, New Mexico, and Arizona. As I have no grounds for accepting these statements, beyond the assertion that most of the bullion is carried away in the pockets of the miners, I am inclined to rely upon the returns of the assessors, express companies, and official tables of export. Admitting that a fraction over seven per cent. may have escaped notice, although reasonable allowance is made for this in the estimates of $70,000,000, and that a considerable sum may be derived from sources not enumerated, I feel confident the additional allowance of $5,000,000 is sufficient to cover the entire bullion product of the United States for the year 1867, thus making the aggregate from all sources $75,000,000, as stated in the report of the Secretary of the Treasury."

TOTAL BULLION PRODUCTION OF THE UNITED STATES FROM 1847 TO 1868.

The production of bullion upon the Pacific coast for the past 20 years has already been stated, p. 21, as amounting in round numbers to $995,944,990. This includes the product of Nevada, Idaho, Oregon, Washington, Arizona, British Columbia, in part, and some from the Mexican coast. It is impossible to ascertain with any precision what portion of this aggregate should be credited to each of these States and Territories, but an allowance of $35,000,000 in round numbers may be

made for the production of British Columbia, and for the receipts from the Mexican coast, which sum having been produced beyond the limits of the United States is to be deducted from the aggregate, leaving $961,000,000, as shown, p. 21.

The following résumé is presented as an approximate estimate of the total bullion product of the United States for 20 years to 1868, and reference is made in explanation to the tables and figures in detail under each State and Territory noticed in the preceding pages:

California, Nevada, Idaho, Oregon, Washington, and Arizona	$961,000,000
Montana	72,000,000
Colorado	30,000,000
Appalachian gold region	10,000,000
New Mexico, Utah, and other unenumerated sources	2,500,000
Total	$1,075,500,000

REVENUE TAX FOR 1867.

The revenue tax of one-half of one per cent. imposed upon all bullion submitted to assay during the year 1867 affords an indication of the bullion production for that period. The tax paid upon gold bullion amounted to $313,618 40 in currency, and upon gold bullion to $90,374 98 in currency. The total estimated value *in coin* of the gold and silver bullion upon which the tax was paid was $58,175,047, this estimate being based upon the assumption that the premium on gold for the year was $38\frac{5}{8}$ per cent., or that $1 in currency was worth 72 cents in coin. The amounts assessed and paid in the different States and Territories are shown in the following table prepared at the office of the Commissioner of Internal Revenue:

States and Territories.	Total value of gold and silver bullion, in currency.	Estimated value of gold bullion, in coin.	Estimated value of silver bullion, in coin.	Total estimated value of gold and silver bullion, in coin.
California	$40,055,718	$27,811,811	[illegible]	[illegible]
Colorado	[illegible]	208,433	....	[illegible]
Idaho	1,472,428	[illegible]	242,211	[illegible]
Montana	[illegible]	1,643,573	63	[illegible]
Nevada	[illegible]	[illegible]	[illegible]	[illegible]
New York	[illegible]	[illegible]	[illegible]	[illegible]
Oregon	[illegible]	[illegible]	[illegible]	[illegible]
Pennsylvania	[illegible]	[illegible]	[illegible]	[illegible]
Utah	[illegible]	[illegible]	....	[illegible]
Washington	[illegible]	225,075	....	[illegible]
Total	[illegible]	[illegible]	[illegible]	[illegible]

DEPOSITS AND COINAGE AT SAN FRANCISCO, 1867.

The following statement furnished to the San Francisco Mercantile Gazette by the superintendent of the San Francisco branch mint of the United States shows the deposits and coinage there during the year ending December 31, 1867:

	Value.
Gold deposits	$18,923,152 17
Silver deposits and purchases	613,117 94
Total deposits	$19,536,270 11

The deposits for the year ending December 31, 1867, were of the following character:

GOLD.

California bullion	$5,700,871 12	
Idaho bullion	1,144,483 04	
Oregon bullion	319,620 90	
Montana bullion	309,843 32	
Nevada bullion	49,030 47	
Arizona bullion	48,797 73	
Parted from silver bullion	168,901 92	
		$7,741,548 50
Fine bars	$10,980,791 94	
Foreign coin	153,453 31	
Foreign bullion	47,358 42	
		11,181,603 67
Total gold		$18,923,152 17

SILVER.

Nevada bullion	$205,618 87	
Arizona bullion	8,425 74	
Idaho	39,727 45	
Parted from gold bullion	69,999 56	
		$323,771 62
Bars	$239,799 25	
Foreign coin	27,595 31	
Foreign bullion	21,951 76	
		289,346 32
Total silver		$613,117 94

Silver bars stamped	$20,534 92
Total gold and silver	19,536,270 11
Fine bars, total	20,534 92

Statement of coinage executed.

Denominations.	No. of pieces.	Value.
GOLD.		
Double eagles	920, 750	$18, 415, 000 00
Eagles	9, 000	90, 000 00
Half eagles	29, 000	145, 000 00
Quarter eagles	28, 000	70, 000 00
Total	986, 750	$18, 720, 000 00
SILVER.		
Half dollars	1, 196, 000	$598, 000 00
Quarter dollars	48, 000	12, 000 00
Dimes	140, 000	14, 000 00
Half dimes	120, 000	6, 000 00
Fine bars	20	20, 534 98
Total	1, 504, 020	$650, 534 98
RECAPITULATION.		
Gold coinage	986, 750	$18, 720, 000 00
Silver coinage	1, 504, 020	650, 534 98
Total	2, 490, 770	$19, 370, 534 98

CHAPTER II.

GOLD REGIONS OF SOUTH AMERICA, CENTRAL AMERICA, AUSTRALIA, AND NEW ZEALAND.

BRAZIL—MORRO VELHO AND OTHER MINES—CHILI—ARGENTINE REPUBLIC—BOLIVIA—PERU—VENEZUELA—NEW GRANADA—CENTRAL AMERICA—AUSTRALIA—GOLD VEINS OF VICTORIA—AUSTRALIAN PLACERS—AGE OF THE DEPOSITS—PRODUCTION OF GOLD IN VICTORIA—QUARTZ MILLS AND MACHINERY—CLUNES, AND OTHER MINES—PORT PHILIP AND COLONIAL COMPANY—NEW SOUTH WALES—EXPORTS OF GOLD—SOUTH AUSTRALIA AND TASMANIA—QUEENSLAND—NEW ZEALAND—STATISTICS OF PRODUCTION.

BRAZIL.

Gold is found in many places throughout the empire of Brazil, but the richest mines yet known are in the province of Minas Geraes, and in the district of Turyassu, in the province of Maranhao. Mining is also conducted on a small scale in the provinces of St. Paulo and Parana, and of Rio Grande do Sul. The metal also occurs in the province of Ceara, on the slopes of the Serra de Ibiapaba, district of Ipu; at the mines of Mangabeira, near Granja, and in the mountains near Baturité. Veins are found at Piancona, in the province of Parahyba,[1] and placers are worked at Mate Grosso.

In some localities palladium is always found associated with the gold, and analyses at the mint in Rio Janeiro have shown the existence of alloys in the following proportions:

Gold	88.9	90.25	92.3
Palladium	11.1	9.75	7.7

Plates of this natural alloy, together with specimens of pure palladium, in plates, wire, and ingots, were shown at the Exposition.

The greatest production of gold in the empire was from the placers, about the middle of the 18th century. The amount on which the royal fifth was paid varied from 17,000 to 21,500 pounds yearly. In 1822 the production was less than 1,000 pounds. According to Humboldt the mean annual production of Minas Geraes from 1810 to 1817 was 4,288 pounds. This large production was obtained chiefly from the placers of the district of Minas Geraes, but these placers became exhausted, and at the present time the chief gold production of Brazil is from the veins or beds worked by English companies.

The rock formations in which the gold occurs are highly metamorphosed sediments, supposed to be of the Palæozoic period. The peculiar elastic, flexible sandstone, known as itacolumite, is largely developed, and is the formation which carries the gold.[2] Varieties of this rock are

[1] Vide "The Empire of Brazil at the Paris International Exhibition of 1867." 8vo, Rio de Janeiro, 1867.

[2] According to Mr. C. M. Wetherill the grains of quartz in itacolumite are interlocked so as to form ball and socket joints. (American Journal of Science, xliv, 61.)

known in the country as itabirite and jacotinga, and differ from the itacolumite simply in containing disseminated scales of specular iron. They are also the varieties which are richest in gold. Similar rocks are found in the gold region of South Carolina and Georgia.[1]

ST. JOHN D'EL REY COMPANY.

According to Mr. Hockin some of the principal gold deposits worked by the St. John d'El Rey company are in a clay state, which is most productive where traversed by a compact mixture of quartz and pyrites. These pyrites consist of arsenical, magnetic, and ordinary iron pyrites, with, occasionally, some copper pyrites. Carbonate of lime, dolomite, and brown-spar are also found. When the sulphurets are absent gold is seldom present.

Morro Velho mine.—This mine, belonging to the St. John d'El Rey company, is probably the most productive and profitable gold mine in the world. Its successful working dates from 1842, since which regular dividends have been paid, and the aggregate profits reach the sum of over five millions of dollars, ($5,000,000.) Valuable details regarding this, and other important mines in Brazil, have recently been given by Mr. Hockin, the managing director of the company, and have been published by Mr. J. Arthur Phillips, in his work upon the Mining and Metallurgy of Gold and Silver,[2] from which they are now extracted:

"The St. John d'El Rey Mining Company was first formed in 1830, for working, on lease, the mines of St. Joao d'El Rey and St. José, near the town of the former name, in the southern part of the province of Minas Geraes, in the empire of Brazil. These mines having been found wholly unproductive, were abandoned in 1834, and the company then purchased the Morro Velho mine and estate, situate at Congonhas, near Sabara, a considerable distance (a degree and a half of latitude) north of the locality of their first operations. The Morro Velho mine had been previously worked by native proprietors for more than a century, chiefly by open cuttings, and with varied results.

"At the time of the purchase of the property by the St. John d'El Rey company, the Morro Velho mine was stated to be yielding a profit; but a considerable outlay having been found necessary, in order to extend the operations and increase the resources of the mine, the company, having had to expend large sums in the purchase of stock and erection of buildings, &c., worked at a loss during the first four years of its possession of the estate. In 1839, the returns, under the management of the late Mr. C. Herring, to whose judgment the company is indebted for the selection of the property, again exceeded the outlay; but the original capital having been exhausted by the losses incurred at the St. John d'El Rey mines, and the purchase of the Morro Velho property, it was

[1] Vide the reports of Oscar M. Lieber, the author, and others.

[2] The Mining and Metallurgy of Gold and Silver, by J. Arthur Phillips, mining engineer. London: E. & F. N. Spon, 48 Charing Cross, 1867.

found necessary to apply the greater portion of the proceeds of the gold extracted to the extension of plant, and it was not until 1842 that the first dividend was declared.

"From that date, with the exception of an interval of 18 months on one occasion (1857–8) and 12 months on another, (1864–'5,) during which the working of the most productive portion of the lode was interrupted by a breakage of the pumping and other machinery, the company has regularly paid dividend every six months.

The original subscribed capital of the company was	£135, 000
Out of which there was returned to the proprietors	6, 600
Net paid-up capital	£128, 400
There has been paid in dividends	£756, 245
Laid out in machinery and buildings on the property, out of profits	140, 000
Stores existing on the property of the value of	39, 000
A reserve fund and working capital has been provided, out of profits, to the extent of	72, 249
	£1, 007, 494

"The total value of the precious metals extracted from the mine has been £2,902,480; the total amount of mineral raised, 1,769,050 tons; the average yield of the ore, 4.333 oitavas, or as nearly as possible half an ounce troy, value, about 32*s.* 6*d.*[1]

"The ores from which these results have been obtained, as will be seen by the following figures, have been, on the whole, poor; the yield has been tolerably uniform, the variations that have occurred being attributable rather to the proportion of slate ground with the ore than to any fluctuation in the quality of the lode itself. Improvements have, from time to time, been made in the mode of treatment, and the loss sustained has been, year by year, steadily reduced.

"The average yield of gold per ton, in oitavas, on the whole quantity of stone annually brought to the surface since the year 1847, has been as follows:

Years.	Oitavas.[2]	Years.	Oitavas
1848	3. 77	1857	3. 06
1849	3. 89	1858	3. 25
1850	4. 07	1859	4. 13
1851	3. 89	1860	4. 52
1852	4. 25	1861	5. 44
1853	4. 34	1862	5. 92
1854	4. 17	1863	5. 78
1855	3. 98	1864	4. 82
1856	3. 52	1865	5. 47

[1] The gold obtained at Morro Velho is usually alloyed with about 20 per cent. of silver.

[2] An oitava is 2 dwt., 7.343 gr. troy, or 8.67425 oitavas=1 oz. troy.

"It should be stated, with reference to these figures, that they do not furnish reliable data whereon to form a judgment as to the increasing or diminishing produce of the auriferous formation in depth, inasmuch as, until recently, no account has been kept of the quantity of clay-slate, or other unproductive stone raised from the mines. During the last six years, excluding 1864, during which a large portion of the killas or clay-slate was stamped with the ore, this unproductive stone has been treated separately, and the proportion it bore to the whole quantity of stuff raised has been as follows, viz:

Years.	Per cent.	Years.	Per cent.
1860	18	1863	22
1861	24	1864	—
1862	24	1865	32

"Whether, during previous years, the quantity of this comparatively unproductive stone was in excess, or otherwise, of the foregoing, there is no means of ascertaining. The formation affording the gold is a strong well defined lode, though irregular in direction, dip, and dimensions: its inclination or underlie has also been found to vary at different depths, and in different parts of its extent. The vein stone is mostly composed of quartz with iron pyrites, disseminated, more or less regularly, throughout its mass, and the lode is not unfrequently traversed by clay-slate and barren white quartz. When pyrites are absent in these rocks, gold is seldom present.[1]

"In some places the vein is cavernous, and less close in its texture than in others; but where drusy cavities are frequent the yield of gold diminishes. The most productive matrix for gold is a compact mixture of quartz and pyrites, with varying quantities of slate. The great metalliferous deposit called the Cachoeira, Bahu, and Quebra Panella, is one continuous, very irregular vein, varying in width from 7 to 70 feet, and at one point reaching 100 feet. The average thickness at the present depth, 176 fathoms perpendicular on the Cachoeira and 165 fathoms on the Bahu, is 19 feet. The stoping place extends over 807 square fathoms. There is a north branch, separated from the main deposit by the enclosing rock, called the Gamba, but its working, having been found unprofitable, has been discontinued. The enclosing rock is a clay slate of tolerably uniform texture. The shafts, so called, for the whole of the lode has been excavated from the surface, are carried down at an inclination of about 45°, and the mineral is brought to the surface by tram carriages of a peculiar construction, carrying large kibbles, containing a ton each. The mineral brought to the surface is first freed from slate and other unproductive stone on the spalling floors, and the ore, after being broken to a uniform size, is stamped fine. The rejected slate and quartz

[1] Arsenical, magnetic, and ordinary iron pyrites predominate at different points, and in varying quantities; carbonate of lime; dolomite, brown spar, and, very rarely, copper pyrites, are also present in the vein.

is removed by tramways to another establishment, half a mile distant, and there employed to assist in the further pulverization of the refuse sand from the first stamping, which is re-stamped.

"The stamping mills, as is also the pumping and other machinery, are moved by water power. The pulverized ore issuing from the stamp coffers, through finely-perforated copper grates, passes over bullock skins, in the first instance, and lower down the inclined tables, over woollen cloths. The bullock skins are taken up and washed in vats every hour, and the woollen cloths at longer intervals. The concentrated sand resulting from washing the bullock skins is subsequently amalgamated in barrels.

"The subjoined table shows the quantities of rock raised and stamped, the amounts of gold produced, and annual net profits made since 1848:

Production of the Morro Velho mine, Brazil, (St. John d'El Rey Mining Company.)

Description.	1849.	1850.	1851.	1852.	1853.	1854.
Stone raised .... tons..	67, 336	67, 106	79, 810	82, 642	85, 698	86, 048
Stone and ore stamped .... do...	69, 004	64, 313	81, 629	81, 236	86, 866	86, 433
Gold produced .... lbs. troy..	2, 583	2, 517	3, 057	3, 323	3, 623	3, 464
Net profit	£38, 136	£35, 880	£51, 586	£55, 391	£49, 273	£44, 740
	1855.	1856.	1857.	1858.	1859.	1860.
Stone raised .... tons..	87, 297	89, 877	86, 407	88, 901	88, 968	91, 361
Stone and ore stamped .... do...	86, 848	87, 424	86, 335	87, 270	82, 880	74, 528
Gold produced .... lbs. troy..	3, 325	2, 992	2, 539	2, 733	3, 294	3, 974
Net profit	£34, 466	£23, 233	£787	£8, 545	£38, 058	£60, 460
	1861.	1862.	1863.	1864.	1865.	1866.
Stone raised .... tons..	96, 612	90, 896	84, 758	65, 435	78, 883	107, 087
Stone and ore stamped .... do...	71, 902	67, 508	65, 607	62, 147	59, 607	60, 685
Gold produced .... lbs. troy..	5, 051	5, 182	4, 713	2, 852	4, 153	....
Net profit	£96, 769	£87, 531	£63, 285	....	£80, 438	£109, 407
Loss	....	....	....	£14, 629	....	....

"Since 1860 the slate and other unproductive stone has been rejected, and the ore only stamped. The clay slate thus separated is crushed in another department of the works. In the above table the profit for that year has been calculated on accounts made up to the end of February, while the other figures given are the result of operations up to the end of December in each year. This company employs upward of 2,400 hands, from 120 to 130 of whom are Europeans. The number of stamp heads at work is 135 for reducing the ore in the first instance, and 56 for re-stamping the residual sand, with slate and quartz; arrastras are also used for re-pulverizing the residual sand, and are found very efficient for that purpose. The work performed by the stamps is given in the following table:

Stamps duty, 1865.

Mills.	Heads.	Blows per minute.	Days working.	Tons of ore stamped.	Tons per day.	Pounds per head per day.
Lyon	30	56	357.46	12,100.6	33.85	2,527
Cotesworth	12	59	356.00	4,932.1	13.85	2,585
Susanna	9	60	361.12	2,897.2	8.02	1,996
Herring	24	77	357.29	11,495.0	31.69	2,976
Powles	36	64	351.24	17,562.6	50.00	3,111
Addison	24	67	353.52	10,619.8	30.04	2,803
Total	135	....	....	59,607.3	167.65	

IMPERIAL BRAZILIAN MINING ASSOCIATION.

"This company was formed in 1825, for the purpose of working the Gongo Soco and other mines in the province of Minas Geraes, and in the course of 15 years produced nearly a million sterling. The following is a statement of the financial operations of the Imperial Brazilian Mining Association at Gongo Soco from January 1, 1826, to December 31, 1856:[1]

Receipts—Proceeds of gold dust			£1,467,448
Payments—Salaries and wages	£432,942		
Materials	451,995		
		£884,937	
Provincial duties paid Brazilian government	£310,777		
Export duties ditto	22,403		
		333,180	
			1,218,117
Profits			£249,331

"Gold was discovered at the surface, 122 fathoms above the bottom of the mines, but, owing to the slope of the ground, the deepest shaft was only 56 fathoms in depth; and for the last 8 or 10 fathoms the vein, which had entirely changed its character, afforded only a few particles of gold.[2]

"*Don Pedro North d'El Rey.*—This company was, on the recommendation of Captain Treloar, formed in 1863, for the purpose of purchasing and working the mine of Morro de Santa Anna. This gold mine forms a portion of the celebrated range of mountains called the Sierra de Itacolumi. The mine is about six miles north from Ouro Preto, the capital of the province of Minas Geraes, and two miles west from the cathedral

[1] Communicated by W. J. Henwood, F. R. S.

[2] This mine was ultimately abandoned, about the year 1858, on account of its poverty.

city of Marianna. It is distant from the St. John d'El Rey Company's mine, Morro Velho, about 40 miles in a southerly and easterly direction. The holding or partition of the mining concession in this locality differs from that of similar property generally in Minas Geraes. In 1762 permission was given by the government to open mines in this mountain wherever the miners might feel inclined, and on doing so they became the lawful possessors of fifty palmos of ground on each side of their levels and shafts. Owing to this the mountain is studded with mines, which the owners from time to time went on selling, until, with a few unimportant exceptions, the whole became the property of the present company. At one period upward of 5,000 miners were working on this mountain, and, in order to extract the precious metal, most of them crushed the mineral obtained by hand, and it must therefore have been rich to have repaid them for their trouble.

"*Rossa Grande Gold Mining Company.*—This company was formed in 1864, to work an extensive mineral property called Rossa Grande, in which are said to be several gold mines. The estate is situated in the province of Minas Geraes, in the vicinity of the mine of Morro Velho. The city of Sabara and several villages are within easy walking distances of the property, and the road from Gongo Soco to Sabara and the St. John d'El Rèy Company's mines passes through it. It is of great extent, and is estimated to comprise an area exceeding 21 square miles, or over 13,000 acres. The climate is said to be salubrious, and the characteristics of the lodes similar to those of the Morro Velho mine.

"The estate contains three distinct auriferous rock formations, which can be traced for miles, besides a jacotinga formation in the direction of Gongo Soco. Diamonds are said to have been found, and the alluvial deposit in the valley is believed to contain sufficient gold to make it remunerative for working. The first rock formation or upper lode is about six feet wide. It consists chiefly of white quartz and iron, and has yielded from 4 to 40 oitavas, or from half an ounce to five ounces of gold per ton.

"The second rock formation or middle lode varies in size from 6 to 12 feet. It is composed chiefly of quartz and auriferous arsenical pyrites. Lumps of gold have been found in it, and the ore in the swells has sometimes afforded 50 oitavas, or upwards of six ounces of gold per ton. The third or lower rock formation is of greater magnitude than the other two, being about 36 feet wide. Its composition is mainly quartz and brown oxide of iron. The whole mass of this lode is said to be auriferous, and portions of it have yielded 50 oitavas of gold per ton. The mine has not yet produced any considerable amount of gold. The greater portion of the time which has elapsed since the formation of the company has been occupied in clearing out the old workings and the erection of machinery.

"*East d'El Rey Company.*—The Morro Sao Vicente mine, worked by this company since 1863, is situated about 24 miles eastward of the Morro Velho mine, and about 22 miles from Ouro Preto, the capital of the prov-

ince of Minas. The highway to the latter from the interior passes through the estate, and the distance from the Emily mines formerly worked by this company is about 17 miles. The estate contains several lodes, but the Champion lode is considered to be more important than the others. The mine is on this lode, which runs obliquely to the clearage planes of the containing rock, its course being south 50° east, and underlies north, at an angle of 45°. This vein belongs to the class of auriferous rock formations. It chiefly consists of quartz, pyrites, galena, tellurium, and gold. It can be traced for some miles, and its width varies from 12 to 30 feet. The rich shutes dip eastward at an angle of 40. The containing rock is clay slate. The mine is situated in a deep hollow, near the western boundary of the property, and consequently does not admit of drainage by an adit: pumping machinery, therefore, is used for this purpose. The excavation has gone down at a less slope than the dip of the lode, and, consequently, it has passed from one layer of the vein into another above it, and, since the returns of gold have been much higher in some months than during others, it follows that they vary in richness; yet, on the whole, the mine has been generally found to improve in descending. Its present depth is about 100 fathoms. This property has, until very recently, made regular returns of gold, but having, in common with other mines in the district, suffered much from want of workmen, who, in consequence of the war in which Brazil is now engaged, have been drafted for military service, it has been obliged temporarily to suspend operations.

"The value of the gold remitted to England during the time the Emily mine was being worked by this company amounted to £5,306 15*s.* 5*d.*

"From the Morro Sao Vicente:

	£	*s.*	*d.*
In 1864	2,852	7	4
1865, to May, 1866	8,588	17	6
Total	11,441	4	10"

CHILI.

Chili has long been known to be a gold producing country, and Humboldt estimates its yearly product in 1800 at 7,500 pounds troy. According to M. Domeyko in his notes upon the mineral richness of the country, accompanying the ores sent by the Chilian government to the Exposition, it is impossible to judge of the production of the gold mines of Chili except by the quantity of the metal coined at the Santiago mint. This, in 1865, amounted to $485,158, and in 1866 to $696,035. To this may be added 33,389 grams (1,071 ounces) of gold exported in bars in 1865, from which is to be subtracted the value of gold from Peru and the Argentine provinces, valued at $61,510, thus reducing the amount for 1865 to about $412,929.

In the mineral collection made in Chili by Lieutenant J. M. Gillis, there

were specimens of gold-bearing quartz exhibiting all the usual characteristics. In the descriptive notice of this collection[1] it is observed that the metal is found in veins traversing granite. It is associated with iron or copper pyrites, arsenical pyrites, blende, galena, and sulphuret of antimony. Mention has been made by M. Crosiner of gold deposits in the midst of decomposed granite and red clay, which do not appear to have been formed by the decomposition of regular veins. This can be seen near Valparaiso. Similar deposits are noticed as occurring in the elevated parts of mountains. The most extensive deposits of gold are on the flanks of the Andes, about 40 miles east of Chillan.

The gold mines of Chili were represented at the Exposition by a series of specimens, Nos. 261 to 265. It is stated in connection with these that in addition to the numerous basins of auriferous alluvions found throughout Chili, there are also veins and metalliferous masses containing gold in all the granitic and crystalline rock formations of the coast and of the interior of the chain of the Andes. Most of the old gold mines which were worked during the domination of Spain are now abandoned, for the reason that the mines of copper, of silver, and of coal are more attractive and profitable to the miners.[2] The following is a description of some of the specimens:

Mine Toro, Coquimbo.—No. 261.—Two large blocks of gold-bearing quartz containing pyrites and a black blende (marmatite,) which is a common associate of gold in Chili. This ore is abundant in the vein of the mine known as Toro, near Andacolle, Coquimbo. In the vicinity of this mine there are extensive placers, which have been worked since before the discovery of America.

At Andacolle there is an extensive metalliferous deposit composed of ore similar to that found at Toro.

No. 262.—Specimens of ore similar to the above but containing cinnabar, which is found in many localities in Chili associated with gold.

Los Remolinos, Department of Copiapo.—Nos. 263, 264.—Two specimens of copper ore, very rich in gold and containing visible gold. These mines also produce native copper and oxide of copper.

Mine Cachiyuyo.—Specimen No. 264, *bis.* Native gold in the sulphuret of copper from this mine.

Mine Castillo de Tiltil, Province of Santiago.—Native gold (No. 265.)

ARGENTINE REPUBLIC.

The mineral regions of this republic are in the Andes adjoining those of Chili. Gold is obtained in the provinces of Mendoza, Rioja, Tontal, and San Juan. The mine El Morada is said to yield ten ounces to the

[1] United States Naval Astronomical Expedition, &c., Appendix D, Minerals and Mineral Waters of Chili, by Prof. J. Lawrence Smith.

[2] Notice Statistique sur le Chili et Catalogue des Mineraux Envoyes a l'Exposition Universelle: Paris, 1867.

ton of ore.[1] There are no satisfactory statistics of the total production, which is probably quite limited, and the metal finds its way, for the most part, into Chili.

URUGUAY.

The statistical and historical notice of the republic of Uruguay circulated at the Exposition states that the departments of the country adjoining Brazil are rich in veins of silver and gold. The auriferous quartz is said to give large masses of the metal. Placers are found and worked upon the streams that descend from the mountains, but the superior attractions of stock-raising have prevented their full exploration. There are mines of argentiferous lead, and considerable quantities of fine agates are exported to Europe.

BOLIVIA.

The gold washings of Romanplaza were represented at the Exposition, but no statistics or other information could be obtained. Gold was formerly produced at Atacama, on the Pacific side of the Andes, and Lieutenant Gibbon cites several localities where gold is, or has been, obtained. The coinage of gold at the mint of Potosi amounted to $11,984 in 1849. According to Phillips, gold washing is carried on with profit at the sources of the Rio Grande, and at Tipoani, near Sorata, at Yungas, and in other localities. The total annual produce is estimated at about 1,600 pounds Troy; value, about $300,000.

PERU.

The Peruvian Andes are rich in gold, which is found in nearly all the rivers. The placers of the river Chuquiaguillo are rich, and have been worked from a remote period. According to Forbes, these deposits appear to have been formed of the debris of Silurian rocks.[2]

Lieutenant Gibbon describes gold mines at Carabanya, on the northeast side of the mountains, where the tributaries of the Madre de Dios take their rise. The metal occurs in quartz or mingled with black dust in a vein, and also in placer deposits. One of the placers worked from May to December, in 1851, yielded 125 pounds of gold. The total annual production of Peru is believed to be about 2,400 pounds Troy; about $500,000 in value.

VENEZUELA.

Mr. Eugene Thirion, consul of Venezuela, exhibited some interesting rich gold bearing quartz from the mines of Caratal, worked by Messrs. Battistini and Trustuck, of the city of Bolivia.

[1] La République Argentine, rapport adressé au gouvernement de S. M. Britannique, par M. Francis Clare Ford, Secrétaire de la legation Britannique: Paris, 1867, p. 52.

[2] Report on the Geology of South America, by David Forbes, F. R. S. Communicated to the Geological Society of London, November 21, 1860. Cited by J. A. Phillips, p. 89.

NEW GRANADA.

Boussingault, Chevalier, and others have given descriptions of the mines of New Granada, but there are no very recent connected statistics of the total production. A correspondent of the New York Tribune, writing under date of May 20, 1868, states that mining is receiving much attention from the people of Antioquia; that much capital is invested in the mines, and that the yield of the precious metals is considerable, reaching, in the month of March, 1868, $132,144 in gold, and $16,075 in silver; a total of $148,219. At this rate the total production of gold per annum would be over $1,500,000, and of silver nearly $193,000. We, however, have no means of knowing whether the monthly production is constant or nearly so.

Mr. Phillips, in his recent work, describes the principal gold-washings as situated in the provinces of Antioquia and Veraguas, "in the former of which the detritus of all the rivers is said to be auriferous; and some quartz veins, occurring in granite and containing iron pyrites, are worked on a limited scale. The principal mines of gold quartz worked in 1850 were on the river Porce, the veins resembling, in every respect, the quartz lodes of other auriferous regions, and containing a considerable amount of iron pyrites and other sulphides." "Quartz veins are also numerous in the provinces of Panama and Veraguas, but the amount of gold contained in them is usually small." Chevalier estimated the yield of the province of Antioquia for the year 1847–'48, at 12,500 pounds. Mr. Danson,[1] from information based on the returns of the British consuls, estimates the total amount produced from 1804 to 1848 at £40,817,066.

Reports of discoveries of new and rich placers in 1865–'66 caused quite an immigration there of miners from California, but the tenure of lands, the climate, and dense growth of vegetation were found so unfavorable to mining that those who were not struck down with the fever of the country left thoroughly disappointed.

MARIQUITA AND NEW GRANADA MINING COMPANY.[2]

"The most important gold mines belonging to British capitalists, now worked in New Granada, are those of Marmato, which are situated in the province of Antioquia. Previous to 1852 these mines were worked by an independent company, but in that year the above association was formed for the double purpose of working the Marmato gold mine and the Santa Ana silver mine, both in New Granada. At the time of their purchase by the present proprietors the mines of Marmato were provided with 12 stamping mills, representing, in the aggregate, 110 heads, which, during the year 1851, had crushed 12,488 tons of stuff, yielding on an average 11 pennyweights 11 grains of fine gold per ton, and resulting in a net profit of £8,343 6*s*. 8*d*. The Marmato mines are worked on deposits of

[1] Journal Statistical Society, London, xiv, 40.

[2] From Phillips's Metallurgy of Gold and Silver.

auriferous pyrites, usually yielding a little more than half an ounce of gold per ton. The quantity of ore raised during the year ending March, 1853, was 15,056 tons, and the quantity stamped 19,089 tons; the total produce being, gold, 10,711 ounces; silver, 5,988 ounces; leaving a profit of £1,144 10*s.* 2*d.*

"During the financial year ending March, 1854, the ores raised amounted to 17,372 tons, and the quantity stamped to 18,225 tons, yielding gold, 10,170 ounces; silver, 5,895 ounces; and resulting in a net profit of £9,767 13*s.* 9*d.* From March, 1854, to 1855, the ore raised amounted to 14,154 tons, and the ores stamped to 18,288 tons, which produced 6,608 ounces of fine gold, and 4,193 ounces of silver; the profit for the year being £3,932 5*s.* 7*d.* In the following year the ores raised amounted to 15,966 tons, and the quantity stamped to 17,668 tons, yielding 6,408 ounces fine gold, and 4,193 ounces of silver, and leaving a profit of £555 14*s.* 2*d.* on the operations of the 12 months. During the year ending March, 1857, the ore stamped amounted to 19,370 tons, yielding 5,635 ounces of gold, and 3,353 ounces of silver obtained, but resulting in a profit of only £541 0*s.* 8*d.*, as a large amount of machinery was erected in the course of this year. In 1859 the profits were £6,918 12*s.* 5*d.*, the stuff crushed 19,598 tons, the gold obtained 6,476 ounces, and the silver 3,874 ounces. The profits in 1860 amounted to £2,778 8*s.* 4*d.*, but we have no data relative to the amount of ore treated, &c. For the year ending March, 1861, the profit was £1,083 18*s.* 5*d.*; the number of tons crushed, 19,431; the yield of gold, 5,039 ounces; and of silver, 3,150 ounces. From the 28th of February, 1861, to the 24th of January, 1862, the operations of the mines were much interfered with by the revolutionary war; only 16,859 tons of rock were crushed, and 2,592 ounces of gold, and 1,663 ounces of silver obtained. The loss on the operations of this year amounted £2,745 15*s.* 9*d.*, and they were afterwards for some time almost suspended.

"After the termination of the revolutionary movement the works were again resumed, and between March 31, 1864, and March 31, 1865, 10,283 tons of stuff were crushed, and about 3,000 ounces of gold, and 1,800 ounces of silver obtained, but the returns were not sufficient to meet the outlay. The Marmato property is at the present time being worked at a profit, and the company has recently acquired the Aguacatal mines, in the immediate neighborhood, from which satisfactory results are anticipated."

CENTRAL AMERICA.

A small quantity of gold is annually produced in the republics of Nicaragua, Honduras, Costa Rica, and San Salvador. In 1852 there was a small mint in Costa Rica, which coined from $50,000 to $100,000 annually, principally in dollar pieces of gold. From a report made by the master of the old mint in 1825 it appears that in the 15 years before 1810 gold and and silver had been coined to the amount of $3,810,382, and he

estimated the actual product of the mines at ten times the amount coined, but that, probably, is too high an estimate.[1] Dunlap observes that the ores of Honduras generally contain from 12 to 15 per cent. of silver, and from 1 to 1½ per cent. of gold. The latter metal is also obtained in the river deposits by the Indians, pieces weighing five or six pounds having occasionally been discovered.

Rich gold washings are reported by the same author at Matagalpa, near Segovia, in Nicaragua. They are also worked by Indians, who annually collect and sell a few pounds.

In the mining district of Chontales, Nicaragua, there are some gold-bearing veins, recently noticed by Commander Pim, royal navy.[2] This district is about midway between Lake Nicaragua and the Caribbean sea, and commences in the town of Libertad, in the mountain range, nearly parallel with Lake Nicaragua. It is several miles wide, but is comparatively little known. There are probably two gold-bearing veins, nearly parallel and trending northeasterly and southwesterly. The mine Jarali, on the river of that name, has been worked to a depth of 150 feet, upon a ridge which may be drained by tunnels. It is assumed to have an average width of three yards, and that it will yield an ounce per ton.

"In the mountain of Aguacate, in Costa Rica, several gold mines were worked with fair profits."[3] (1847.)

CUBA AND SAN DOMINGO.

The committee of agriculture, industry, and commerce, of Remedios, Cuba, exhibited specimens of ores of gold from the mine San Blas, in the district of Guaracabuya, and from San Atanasio, a league and a half distant from San Blas.

These veins are described as occurring at many places in the district, and some have been explored to a depth of 60 feet and a length of 300 feet. The gold is found in extremely small scales or points between the layers of dioritic rock or slates and of serpentine. It is associated with iron pyrites and arsenical pyrites, and occasionally with tellurium. The vein of San Atanasio varies from three centimetres to 21 centimetres in thickness. In both of these localities there are traces of ancient work by the aborigines.

Gold placers of considerable extent are known to exist in San Domingo, but they were not represented at the Exposition.

AUSTRALIA.

The gold of the Australian continent was represented in the Exposition by a variety of specimens of the quartz lodes, or reefs, specimens of the

---

[1] Vide Nicaragua, People, Scenery, Monuments, &c., by E. G. Squier: Introduction, p. 40.

[2] The Chontales mining district, Nicaragua, by Commander Bedford Pim, royal navy. A paper read at Dundee, September 7, 1867, before the British Association for the Advancement of Science. Published in the Mining Journal, September 14, 1867.

[3] Dunlap's Central America, pp. 227 to 284.

native gold, models of the large nuggets, and several series illustrative of the character of the gravel deposits or placers. These, and the veins were still further illustrated by geological maps and sections, and by descriptive and statistical publications.

Among these objects we noted the model of the celebrated "Welcome nugget," which was found in June, 1858, at the diggings of the Red Hill Mining Company's claim, Pakery Hill, Ballarat. This weighed 2,217 ounces, 16 pennyweights, and was valued at nearly £10,000. But the most prominent object was a tall gilded pyramid representing the aggregate bulk of gold obtained in the Colony of Victoria from October, 1851, to October, 1866, a period of 15 years. This pyramid was 10 feet square at the base and 62 feet 5½ inches high. Its bulk in cubic feet was 2,081½, and it represented a value of £146,057,444 sterling, about $730,000,000. It was made of carpentry in sections, fitting one upon another; the outside covered with stout canvas, upon which gravel and grains of sand or broken plaster were glued and then gilded over so as to imitate the appearance of a pile of gold nuggets and dust as it comes from the mines.

VICTORIA.

This colony is situated at the southeast of the continent of Australia, and lies between the 34th and 39th parallels of south latitude and the 141st and 150th meridians of east longitude. Its extreme length from east to west is about 420 miles, and its greatest breadth about 260 miles. Its extent of coast line is nearly 600 miles. It is often mistaken by writers for the adjoining colony, known as South Australia. Its area is 86,831 square miles, being nearly as large as that of Great Britain.

This colony has produced more gold than any other division of Australia. The metal was first discovered at Clunes in March, 1850, and licenses to dig were first issued in 1851. The actual area now mined upon as stated in the "Mineral Statistics of Victoria," 1865, is 725$\frac{11}{12}$ square miles, and the estimated number of quartz veins known is 2,029. "These veins traversing lower palaeozoic strata and associated with granitic and igneous rocks are, so far as is at present known, the primary source of the whole of the gold raised in Victoria. The thickest and most persistent veins, or 'lines of reef,' are found on the lower or older portions of the series; but the average yield of gold per ton of stone has, I believe been greater from the thinner veins of the upper beds."[1] These veins are described as "dikes or reefs," and are from the thickness of a thread to 130 feet. They generally have a meridional direction and are inclined at all angles either to the east or west; are often vertical, and sometimes horizontal. Occasionally they coincide with the planes of stratification but they usually follow the cleavage planes or joints, and often they intersect all.

[1] From Notes on the Physical Geography, Geology, and Mineralogy of Victoria, by Alfred C. Selwyn, Director of the Geological Survey: Melbourne, 1866.

The greatest depth to which any vein has been worked in Victoria was 630 feet, (1866,) at the Victoria company's mine, Clunes. At the depth of 444 feet in the Port Phillip company's mine one ounce of gold per ton has been obtained, and the experience in Australia, as in California, shows that veins do not grow poorer in depth.

The heaviest nugget or connected mass of gold known to have been found in a quartz reef in the Colony weighed nearly 13 pounds, and came from a depth of 40 feet from the surface at Old Quartz Hill, Castelmaine. Gold has been observed in sandstone, as at Prior's reef, Castelmaine, and in diorite,[1] and limestone.

In the specimens at the Exposition illustrating the character of the auriferous reefs of the colony, there were some which resembled the Nova Scotia gold quartz more than the California. The gold has a higher color, and is finer than that from California. One of the specimens (No. 186) resembled the quartz of Grass Valley. Another contained a large amount of sulphuret of antimony in close association with the free gold. In regard to the fineness of Victorian gold, Mr. Ulrich observes that it ranges between 20 and 23.5 carats, the Ballarat gold being of the highest standard. From only one district, Lake Omeo, is the standard reported as below 16 carats, and the alloy is copper, with a trace of silver.

Mr. Selwyn has arrived at the conclusion that there are at least two distinct sets of quartz veins in Australia, one of which is quite barren, and has never yielded any gold to the miners or to the ancient streams and placers. He regards the veins as having been formed at two different and remote periods, the barren set being the oldest, formed before the Miocene or Middle Tertiary period, and the productive ones during the Miocene period, or anterior to the distribution of Pliocene gravels, which are found to contain gold, while the older drifts do not contain it. In further support of his conclusion that there are two sets of quartz veins, he mentions a fact well known to experienced quartz miners and prospectors in Australia, that in many districts there are quartz ledges that are entirely barren, in close proximity to those that give handsome returns. This fact is a familiar one also to American quartz miners, not only in California, but in the Appalachian gold field, and it suggests the probability of there being quartz lodes of two or more distinct periods in America as in Australia.

AUSTRALIAN PLACERS.

By far the largest portion of gold obtained in Australia is from gravel deposits or placers like those in California. They are either in the beds of existing streams, or in terraces along the banks, or in ancient channels running transversely to the existing drainage of the country. Many of the richest deposits are found under heavy accumulations of stratified tuffs and lavas, with layers of basalt on the top forming table mountains, as in California. There is a great difference in the thickness of these

[1] Ulrich, Geology and Mineralogy of Victoria, p. 41.

placer deposits in different places. In some that are not covered by basalt they have been found to be from 130 to 140 feet thick, and in one instance a shaft has been sunk to a depth of more than 400 feet, passing from top to bottom through a conglomerate formed of water-worn pebbles and blue clay, and had not reached the bed-rock in 1865.

Of the age of these deposits Mr. Selwyn observes as follows: "The exact period in the Tertiary epoch, where the gold drifts commenced, is at present exceedingly doubtful. No beds are yet known in Victoria associated with, or forming a portion of such drifts, that contain fossil marine animals. Neither has any gold been obtained from beds below the known fossiliferous Tertiary strata. The volcanic rocks, consisting chiefly of varieties of trachytic dolerites, basalts, trachytic porphyries, &c., are in many districts inter-stratified, in contemporaneous layers, with the sands, clays, and gravels, of what are at present considered to be the oldest gold drifts, in which the lowest stratum, where the gold occurs, almost invariably consists of a water-worn quartz gravel. That there are gold drifts marking at least three distinct deposits, the results of successive upheavals and depressions, is quite certain; and it is now almost equally certain that the earliest of them was the result of the commencement of the oldest pliocene period. In accordance with this view they have been divided into older Pliocene, newer Pliocene, and post Pliocene deposits. These three stages sometimes occur in the same locality without the intervention of any volcanic rocks, in which case three bottoms or gold-bearing strata are found in one shaft, the last being always on the solid, unmoved Palaeozoic rock. About 400 feet is the greatest known thickness of these older Pliocene deposits, including the associated volcanic rocks, and at this depth rich deposits of gold are found in them resting on the slopes, and in the hollows of what was once the old Pliocene sea-bed. The exact relations of the gold-bearing drifts of the upper Tertiary periods to the marine Tertiary sands, clays, and limestones of the Miocene and Eocene series, is a very interesting point in Victorian geology not yet elucidated, and one which may have an important bearing on the probable extension of the deep gold leads of Ballarat and other gold fields.

"In following the leads they are invariably found to deepen in the general direction of the existing surface water shed. Thus, at Ballarat and other gold fields on the south side of the dividing range, they deepen in a southerly direction; while at Clunes, Bendigo, &c., they invariably deepen in the opposite or northerly direction, and there seems no reason why they should not extend underneath a very large part of the extensive plains that stretch from the northern gold fields to the Murray, and from the southern flank of the dividing range to the seaboard, wherever the tertiary rocks forming these plains rest directly on the lower palaeozoic strata."

There appears however to be some doubt whether gold may not be, or has not in reality been, found in some of the deposits considered as

Miocene, for it appears by an observation of Rev. W. B. Clarke, in his paper upon the sedimentary formations of New South Wales, accompanying the exhibits of that colony in the Exposition,[1] that gold has been discovered in the so-called Miocene deposits of Victoria. Mr. R. B. Smyth, in his Intercolonial Exhibition essay, cites the fact that rich quartz has been obtained from great depths in these Miocene deposits, and this may possibly be the gold that Mr. Clarke refers to, but it will be seen at once that quartz veins may be found in the Miocene Tertiaries, without affecting the conclusion of Mr. Selwyn in regard to the barrenness of Miocene drifts.

The regions of Ballarat and Bendigo have been the most productive. Ballarat is the centre of the gold districts of Clunes, Creswick, Smythe's, Egerton, Gordon, Steiglitz, Linton's, Carnham, &c. Bendigo, the most important gold field of the Sandhurst district, was originally a shallow gold field, some of its famous gulleys yielding many ounces to the tub having been scarcely a yard in depth. In place of these placer diggings, now nearly or quite exhausted, the chief industry of Bendigo is quartz mining, which extends over an area of some 40 square miles.[2]

The attention of the geological survey of Victoria has latterly been directed to the very important question of the age and probable auriferous or non-auriferous character of what are called "the lower drifts of Victoria," and from the facts observed the following conclusions have been arrived at:[3]

"1. That these particular drifts are clearly antecedent in date to the upper and middle Miocene beds, under which they have now been traced, and, therefore, that they are far older than the lowest Pliocene gravels, to which age the "deep-lead" gravels of Bellarat, the White hills of Bendigo, and other similar rich gold-bearing gravels have been referred.

"2. That they do not probably contain gold in paying quantity, the reason being that they are derived from the abrasion of quartz veins that themselves contained little or no gold, and that were probably formed by forces in operation as long prior to those which produced the gold-bearing veins, as the denudations producing the barren Miocene gravels were prior to those which gave rise to the Pliocene productive ones.

"I will now briefly state the facts which have led to these conclusions:

"During the progress of the geological survey, deposits from a mere capping to over 300 feet thick have been met with in several localities, from sea level to an elevation of 4,000 feet. These consist of beds of clay, sand, cement or conglomerate, gravel, and large boulders, the gravel and boulders much water-worn and rounded, and composed either of quartz, quartz rock, or hard silicious sandstone. They rest on

---

[1] Catalogue of the Industrial Products of New South Wales, forwarded to the Paris Universal Exhibition of 1867. Printed by authority of the government commissioners. 8vo.

[2] Phillips. Mining and Metallurgy of Gold and Silver, p. 112.

[3] These were published as a parliamentary paper, 8th May, 1866, and are republished by Mr. Selwyn in his "Notes on the Physical Geography, Geology, and Mineralogy of Victoria," Melbourne, 1866, and distributed at the Paris Exhibition. See pp. 21, 22.

the ordinary slates and sandstones (Silurian) of the gold fields, and are often in the vicinity of rich gold-bearing quartz reefs.

"Till quite recently I have considered these deposits to be true older Pliocene gold-drifts, or of the same age as the rich lower drifts of Bendigo, Epsom, Ballarat, Castlemaine, and other gold fields, all of which drifts they very closely resemble both in lithological character and geological position. Holding this position, I have hitherto been at a loss to explain why they had in no instance been found to contain gold in paying quantity. Numerous shafts had been sunk, and levels driven in them in the most likely places, in various localities, both by miners and by the geological survey parties, with a view to develop their supposed auriferous contents, but always with the same unsuccessful result."

PRODUCTION AND EXPORT OF GOLD IN VICTORIA.

The following statistics of the production and movement of Victoria gold are taken from the essay of Mr. Archer, circulated at the Exposition:[1]

"The exports of gold, the produce of Victoria, in 1865, amounted to 1,543,149 ounces. This quantity was about 2,249 ounces short of that in 1864. The total quantity of Victorian gold which passed through the customs of this and the adjacent colonies since the first opening of the gold fields amounts to 32,272,793 ounces, representing, at £4 per ounce, a value of £139,091,172. The following are the quantities exported in each year:

Net exports of Victorian gold from 1851 to 1865, inclusive.

Year.	Quantity.			Year.	Quantity.		
	Oz.	*dwt.*	*gr.*		*Oz.*	*dwt.*	*gr.*
1851	145,137	3	12	1860	2,156,660	12	0
1852	2,738,484	0	13	1861	1,967,453	11	0
1853	3,150,020	14	16	1862	1,658,241	17	0
1854	2,392,065	9	19	1863	1,627,066	7	0
1855	2,793,065	8	16	1864	1,545,308	3	0
1856	2,985,695	17	0	1865	1,543,148	19	0
1857	2,761,528	8	0				
1858	2,528,487	19	12	Total	32,273,792	13	16
1859	2,280,678	3	0				

"In addition to the above there were probably 150,000 ounces lodged in the Victorian treasury, and in the hands of the colonial banks and gold brokers, at the end of 1865. It was estimated some years ago by one of the principal Melbourne gold-brokers, who had every opportunity of being well informed on the subject, that from the first discovery of gold to the end of 1859, 1,931,869 ounces had been taken out of the colony by private hands, without being passed through the customs. This esti-

[1] The Progress of Victoria: a Statistical Essay by William Henry Archer, Registrar General of Victoria, &c., &c. Melbourne, 1867.

mate brought down to the end of 1865, in the same proportion as the gold appearing in the customs returns, would make the total quantity of unrecorded gold taken out of the colony from the commencement to that date equal to 2,863,247 ounces, which being added to that which passed through the customs, and that in possession of the treasury, banks, &c., would make the total produce of the Victorian gold fields, to the end of 1865, amount to 35,286,040 ounces, which, at £4 per ounce, would represent a value of £141,144,160."

To this may be added the production for the years 1866 and 1867, the first being stated approximately in the mineral statistics of Victoria for the year 1866 as 1,479,194¾ ounces; value at £4 per ounce £5,916,779, about $29,583,895.

Later returns received since the foregoing was written state the yield of Victorian gold for 1866 as 1,480,597 ounces, and for 1867 1,392,336 ounces,[1] and for other years as follows, differing slightly, as will be seen, from the amount given for corresponding years in the preceding table:

Year.	Ounces.	Value at $19 04.
1863	1, 627, 066	$30, 984, 336
1864	1, 545, 450	29, 425, 368
1865	1, 556, 088	29, 627, 916
1866	1, 480, 597	28, 190, 566
1867	1, 392, 336	26, 510, 077

By adding the value of the production for 1866 and 1867 to the estimate of the total value up to 1866, viz., £141,144,160, we have $760,000,000 as approximately the total production of Victoria to the present time.

The gradual diminution in the export since 1862 will be observed. A writer in Dicker's Mining Record says:

"It has been the custom to attribute this falling off in the yield of the gold-fields to a decrease in the number of miners, who, for various reasons, have embarked in other pursuits, and permanently forsaken the gold-fields. The returns of the number of miners employed throughout the year would seem to bear out this view. In 1865 the number of miners employed throughout the year was 83,214; in 1866, 73,557; and in 1867, 65,857; a reduction as between 1865 and 1867 of 17,357 miners. The decrease has been alike gradual among miners employed in alluvial and quartz workings. In 1865 the number of alluvial miners was 62,131; in 1866, 55,916; and in 1867, 51,719. The number of quartz miners in 1865 was 17,326; in 1866, 14,878; and in 1867, 14,138. Whether this reduction will prove continuous is a matter for conjecture. The spirit of speculation in regard to mining adventures indicates that capital is forthcoming whenever there is legitimate occasion for its use, and recent events at Ballarat tend to encourage the belief that there is yet an almost inexhaustible treasure remaining in the soil. The decrease in

[1] Extract from Dicker's Mining Record, published in the American Journal of Mining.

the yield of gold has not been proportionately greater than the decrease in the number of miners, and their wages have consequently improved yearly. In 1860 the average annual earnings per man were, in round numbers, £79; 1861, £74; 1862, £67; 1863, £70; 1864, £74; 1865, £74; 1866, £80; and 1867, £80."

According to the mineral statistics of Victoria for 1866, the ratio of vein gold from quartz mines to the placer gold was as follows:

From quartz veins	521,017 ounces.
From placers	958,177¾ "

The number of quartz miners employed in the different districts was as follows:

Ballarat	2,005
Beechworth	2,941
Sandhurst	1,118
Maryborough	2,292
Castlemaine	2,648
Ararat	874
Total	14,878

Although the returns for 1866 of the yield of gold from the quartz veins do not include all the mines of the different districts, they are very complete and instructive, and give accurate information relative to an aggregate amount of 861,468$\frac{13}{20}$ tons, which yielded 452,895 ounces 7 pennyweights, or an average of 10 pennyweights 16.2 grains per ton.

Mining districts.	Tons crushed.	Total product.		Yield per ton.	
		oz.	dwt.	oz.	dwt.
Ballarat	238,503½	58,157	3	4	21
Beechworth	130,519 11-20	118,195	19	18	3.7
Sandhurst	244,867¼	118,743	10	9	[illegible]
Maryborough	79,552 3-5	44,967	14	11	7.3
Castlemaine	124,374¼	85,052	[illegible]	13	[illegible]
Ararat	43,711	33,868	[illegible]	15	[illegible]
Totals	861,468 13-20	452,895	7	10	16.2

The prices paid for working quartz ranged from 4s. to £1 10s. per ton. The number of steam-engines in operation during 1866 was: Alluvial mining engines, 480; aggregate horse power, 9,981. Quartz mining engines, 510; aggregate horse power, 9,231. Number of stamp heads, 5,437. In 1865, according to Mr. Archer, "the machines used in gold mining, at the end of 1865, numbered 6,337, representing an approximate total value of £1,773,271. The number of steam engines working was 964, of which 473 were employed in alluvial and 491 in quartz mining. The aggregate horse-power of the former was 8,208; that of the latter was 8,606, making a total of 16,814. The following machines were used

in alluvial mining: 3,228 puddling machines, 427 whims and pulleys, 115 whips, 78 horse-pumps, 648 sluices and toms, (having 4,428 sluice-boxes,) 196 water-wheels, 33 hydraulic hoses, 102 pumps, 8 derricks, 25 crushing machines, (having 461 stamp heads,) and 4 boring machines. The following machines were used in quartz mining: 99 crushing machines, (having 5,119 stamp heads,) 231 whims and pulleys, 56 water-wheels, 15 derricks, 98 whips, and 10 quicksilver cradles."

Some further details regarding the number of machines in use, and the average yield of the quartz of different districts, are cited by Mr. Phillips from the surveyor's reports for 1860. It appears that in that year 61,075 tons of quartz from the Ballarat district yielded 38,378 ounces 6 pennyweights of gold, or an average of 12 pennyweights 13 grains per ton.

From the Beechworth mines 3,725 tons 16 hundred weights of quartz gave 13,862 ounces 6 pennyweights of gold, = 3 ounces 14 pennyweights 10 grains per ton.

The Sandhurst district afforded 2,578 tons 15 hundred weights of quartz, yielding 6,361 ounces 8 pennyweights of gold, = 2 ounces 7 pennyweights 12 grains per ton.

From the Maryborough district there were crushed 4,548 tons, producing 6,345 ounces 1 pennyweight of gold, = 1 ounce 7 pennyweights 21 grains per ton.

The district of Castlemaine produced 13,301 tons 15 hundred weights, affording 14,955 ounces 11 pennyweights of gold, = 1 ounce 2 pennyweights 11 grains per ton.

Ararat yielded 1,265 tons 10 hundred weights of quartz, which gave 2,002 ounces 10 pennyweights of gold, = 1 ounce 11 pennyweights 15 grains per ton.

In the same year there were 294 steam-engines, of the aggregate horse-power of 4,137, employed in alluvial mining, and 417 engines, of the aggregate power of 6,645, employed in quartz mining. There were, in addition, 138 water-wheels and 3,958 horse-puddling machines in operation. The total approximate value of the mining plant in the colony was, at the same period, estimated at £1,299,303.

CLUNES AND OTHER GOLD MINES—VICTORIA.

The following special descriptions of the Clunes and other important Victorian mines are extracted from the work of Mr. Phillips, p. 114, and are, in part, cited by him from Dicker's Mining Record:

Clunes.—*Port Phillip and Colonial Gold Mining Company.*—This is the most important and extensive quartz-mining enterprise in the colony. The extent of the claim is 160 acres, held on a lease for 21 years, from 1st January, 1857, at a royalty of seven and a half per cent. on the gross value of the gold raised. Operations were commenced by the present company in 1857, and in the following year Mr. Selwyn, the government geologist, thus writes of its mines and establishments:

"Within the last 12 months I have visited all the principal quartz reefs and crushing establishments on the northern and western gold fields, and the Port Phillip and Colonial and Clunes company is the only one I have seen of which it would be possible to say that it leaves little to be desired, either as regards the system of working the mine, or the general arrangement and management of the machinery."

The reefs worked are five in number, and are enclosed in a soft white and brown slaty sandstone, which, like the veins themselves, runs nearly north and south, and generally dips toward the east. With the exception of the overlying tabular basalt, no igneous rocks occur on the surface within three miles of these veins. The nearest granite is at Mount Beckworth, nine miles west of the company's property. Nearly three-fourths of the land held by the company is occupied on the surface by a stratum of tabular basalt, and it is only in the southwestern corner, where this rock has been removed by denudation, that the shales and sandstones, with their associated quartz veins, come to the surface.

The greatest depth to which the Clunes has been worked is 485 feet, and the total amount of quartz treated since the commencement of operations in 1857, to October, 1866, has been 319,695 tons, yielding 185,488 ounces 8 grains of gold, giving an average produce of 11 pennyweights 14½ grains per ton. Mr. C. H. Fielder, the secretary of the company, furnished the information embodied in the following tables:

Return of quartz crushed from June, 1857, to October, 1866.

Period.	Quartz crushed.	Net amount of gold produced.			Average per ton.			Royalty.			Total.		
	Tons.	*Oz.*	*dwt.*	*gr.*	*Oz.*	*dwt.*	*gr.*	£	*s.*	*d.*	£	*s.*	*d.*
1857, (seven months)	4,146½	6,780	14	8	1	12	17	2,650	11	1	26,764	4	6
1858, (nine months)	11,320½	15,764	9	0	1	7	20	6,130	2	2	61,304	3	5
1858-'59, (one year)	17,542	18,165	12	12	1	0	17	6,202	15	8	71,497	4	5
1859-'60, (one year)	21,094	17,466	16	9	0	16	0	5,135	14	4	68,476	5	9
1860-'61, (one year)	32,258	21,326	6	3	0	15	2	7,178	3	2	95,708	13	3
1861-'62, (one year)	34,236	22,012	0	17	0	12	20	6,479	18	4	86,338	12	11
1862-'63, (one year)	40,360	22,988	1	19	0	11	9	6,850	4	5	91,857	5	8
1863-'64, (one year)	44,149	17,611	8	0	0	8	0	5,227	1	9	69,694	7	2
1864-'65, (one year)	54,413	20,596	15	12	0	7	13	6,074	3	0	80,682	7	8
1865-'66, (one year)	59,576	19,775	16	0	0	6	15	5,893	16	10	78,584	[illegible]	1
Total	319,695	185,488	0	8	0	11	14	57,822	10	9	733,45[illegible]	[illegible]	[illegible]

The subjoined table gives the monthly results of the operations of the company in Victoria from January, 1865, to June, 1866, both inclusive. The crushing apparatus consisted of seven stamping-mills or batteries, composed in the aggregate of 80 heads, each weighing, including the stem, from six to eight hundred weight.

PORT PHILLIP AND COLONIAL GOLD MINING COMPANY.

Cost and returns from January, 1865, to June, 1866.

Period.	Quartz stamped.	Quartz stamped per week.	Duty per stamp per day.	Produce of gold.	Produce per ton.	Gold per ton in tailings by assay.	Total mine cost per ton.	Total reduction cost per ton.	Pyrites. Treated.	Pyrites. Yield per ton.	Pyrites. Profit.	Price of gold per oz.	Proceeds of gold.
1865.	*Tons.*	*Tons.*	*Cwt. qr.*	*Ounces.*	*Dwt gr.*	*Dwt. gr.*	*£ s. d.*	*£ s. d*	*Tons.*	*Oz. dwt.*	*£*	*£ s. d.*	*£*
January	3,412	853	49 0	1,039	6 2	1 15	......	......	......	......	......	3 16 0	4,147
February	4,551	910	48 2	1,566	6 22	1 15	......	......	......	......	......	3 16 0	6,272
March	3,677	919	54 0	1,006	5 11	1 22	0 11 0	0 7 9	85	2 7½	460	3 16 0	4,163
April	3,326	831	58 0	868	5 5	1 3	0 16 0	0 6 6	......	......	......	3 16 0	3,434
May	6,142	1,024	58 0	1,824	5 22	1 20	0 15 6	0 5 2	......	......	......	3 16 0	7,213
June	4,530	1,132	56 0	1,836	8 2	2 3	0 14 9	0 7 0	......	......	......	3 16 0	7,322
July	4,688	1,172	57 0	1,761	7 12	1 23	0 13 2	0 5 6	23	3 1½	208	3 16 0	7,026
August	4,787	1,197	57 2	2,254	9 10	2 15	0 12 8	0 5 6	25	3 1	222	3 16 0	9,019
September	6,817	1,136	54 0	3,465	10 4	1 22	0 14 11	0 5 2	30	4 12	413	3 16 0	13,725
October	4,774	1,193	56 3	1,997	8 8	2 3	0 11 2	0 7 3	......	......	......	3 15 4	7,876
November	4,676	1,169	57 3	1,661	7 2	2 15	0 14 7	0 8 2	......	......	......	3 15 1	6,562
December	4,195	1,049	54 3	1,316	6 7	2 6	0 16 1	0 11 2	......	......	......	3 14 10	5,172
1866.													
January	4,177	1,044	53 0	1,377	6 14	2 6	0 15 3	0 9 4	......	......	......	3 14 10	5,438
February	4,511	1,128	53 2	1,602	7 2	1 22	0 13 11	0 8 0	105	3 1	856	3 14 10	6,319
March	4,830	1,207	57 0	1,514	6 6	1 23	0 11 9	0 6 7	......	......	......	3 15 4	5,999
April	6,778	1,129	55 0	1,946	5 18	2 6	0 10 10	0 6 6	40½	2 10	280	3 15 4	7,728
May	4,783	1,196	57 0	1,111	4 15½	1 16	0 11 0	0 6 2	19	2 11	......	3 15 9	4,435
June	4,877	1,219	63 3	911	3 17¾	1 17	0 10 6	0 7 0	19	3 3	286	3 15 9	3,616

BALLARAT.—The following workings in this locality are classed as alluvial:

Cosmopolitan.—Commenced 1857; claim 880 feet on the gutter; basaltic rock 112 feet in thickness; total length of drivages, 2,500 feet; stuff puddled and washed up daily. This undertaking had produced 38,249 ounces 4 pennyweights 19 grains of gold, of the value of £152,442, and paid dividends to the amount of £125,454 up to November 19, 1864.

United Extended Band of Hope.—Extent of claim, 36,040 feet; commenced in 1856, and had yielded gold to the value of £259,547; of which amount £147,200 had been paid in dividends up to 31st December, 1865.

Defiance Company.—Commenced 1856, and had afforded 20,197 ounces 18 pennyweights of gold, of the value of £81,102; out of which £66,483 had been paid in dividends up to December 24, 1864.

Koh-i-noor.—Commenced 1857; produce, 60,332 ounces; value, £241,233; dividends paid, £176,080, up to December 6, 1864.

Prince of Wales.—Commenced February, 1857; gold produced, 22,912 ounces 11 pennyweights 19 grains; value, £90,735; dividends paid, £51,552, up to December 10, 1864.

Alston and Weardale.—Commenced July, 1858; gold produced, 2,585 ounces 15 pennyweights 3 grains; value, £10,451; dividends paid, £4,884, up to August, 1864.

Great Extended.—Commenced 1857; amount of gold produced, 82,754 ounces 9 pennyweights 14 grains; value, £325,967; dividends paid, £274,150, up to December 4, 1864.

BUNINYONG.—*Buninyong Mining Company.*—Alluvial; commenced November, 1857; gold produced, 43,175 ounces 16 pennyweights 22 grains; value, £172,695; dividends paid, £88,007, previous to November 26, 1864.

DAYLESFORD.—*New Wombat Hill.*—Alluvial; commenced April, 1861; gold produced, 14,942 ounces 14 pennyweights 19 grains; value, £58,059; dividends paid, £38,400, up to November 5, 1864.

BENDIGO.—*Catherine Reef United.*—Quartz; claim, 501 yards, held under a lease from the government; vein, 4 feet wide, with strike 23° west of north, and a dip to the east; commenced March, 1861; gold produced, 24,930 ounces 15 pennyweights 12 grains; value, £95,784; dividends paid, £29,735, previous to December 17, 1864.

SCARSDALE.—*Aroncliff.*—Alluvial; area of claim, 133 acres; depth of basalt, 84 feet; 2 gutters running parallel; depth of wash dirt, 1½ feet; gold produced, 4,272 ounces 14 pennyweights 12 grains; value, £17,090; dividends paid, £4,000, up to September, 1864.

HAPPY VALLEY.—*British Gold Mining Company.*—Alluvial; extent of claim, 50 acres; held under a lease from the government; the gutter is 30 feet in width, and the depth of the wash dirt about 3 feet; commenced in July, 1860; produce of gold, 17,591 ounces 6 pennyweights 1 grain; value, £70,126; dividends paid, £40,800, up to March 4, 1866.

Try Again Gold Mining Company.—Alluvial; commenced September, 1859; extent of claim, 49 acres; held under a lease from the Crown;

wash dirt from 2 to 3 feet in thickness; gold produced, 6,153 ounces 7 pennyweights 8 grains; value, £24,535; dividends paid, £9,802, up to December 10, 1864.

Cleft in the Rock.—Alluvial; commenced November, 1859; extent of concession, 50 acres; held under a lease from the Crown; main lead bearing north and south; thickness of pay dirt from 2 to 7 feet; produce of gold, 3,848 ounces 14 pennyweights 11 grains; value, £15,287; dividends paid, £5,960, up to December 12, 1864.

WOOD'S POINT.—*Alps Great Central Gold Mining Company.*—Quartz; commenced July, 1863; produced 27,500 ounces of gold; value, £92,812, up to July, 1865.

Hope Mining Company.—Quartz; commenced July, 1863; produce of gold, 8,732 ounces 3 pennyweight; value, £27,032, up to July, 1865.

NEW SOUTH WALES.

This new colony next adjoins Victoria upon the north and west, and is the oldest settled portion of Australia, having been founded by the government of Great Britain as a penal settlement in the year 1788. As a gold-producing region it cannot rank with Victoria, and the statistical returns are not as complete. The total production, up to the close of 1860, amounted to about £8,000,000, while the exports from Victoria amounted to nearly £90,000,000 for the same period. According to the government returns, entitled Statistical Abstract for the several Colonial and other Possessions of the United Kingdom, 1866, cited by Mr. Phillips, the export of coined and uncoined gold from this colony up to 1864 had been nearly as follows:

Exports of coined and uncoined gold, New South Wales.

Period.	Quantity.	Value.
	Ounces.	
1851	144,120	£470,836
1852	818,751	2,660,945
1853	548,152	1,781,272
1854	237,910	773,209
1855	64,384	209,250
1856	46,999	156,151
1857	277,531	1,101,448
1858	443,462	1,773,851
1859	427,558	1,704,774
1860	472,886	1,878,588
1861	507,021	2,010,263
1862	741,055	2,984,269
1863	593,699	2,362,054
1864	740,048	2,952,471
Totals	6,063,576	£22,819,381

Mr. Phillips observes that it is probable a large part of the gold exported from New South Wales is the product of other portions of Australia, and estimates the total produce of the gold fields, since their discovery

in 1851, as not more than 4,000,000 ounces, and the present annual yield as 320,000 ounces, value at $19 per ounce, $6,080,000.[1]

According to the Rev. W. B. Clarke, the gold, as in Victoria, is derived chiefly from the Lower Silurian formation, but he believes it to exist in almost every distinctive rock in New South Wales. The alluvial deposits are not so extensive as in Victoria, and it is found difficult to assign them with any precision to the epochs adopted by Mr. Selwyn for the latter. The gold alluvia of the Uralla rest chiefly on granite, and are covered by a great thickness of basalt, as in the Victoria fields, and are probably of the same period.

SOUTH AUSTRALIA AND TASMANIA.

These colonies also produce a small amount of gold annually, valued in the aggregate, from 1851 to 1860, at £374,000, one-half of which is supposed to have come from New Zealand. The following table of the amounts and value of gold exported from these colonies, including some from New Zealand, from the discovery of gold to the close of 1860, is given by Mr. Phillips, page 121:

Exports of gold, including some from New Zealand.

Year.	Quantity.	Value.
	Ounces.	
1852	5,250	£21,000
1853	5,250	21,000
1854	5,250	21,000
1855	5,250	21,000
1856	5,250	21,000
1857	15,639	62,556
1858	18,680	74,720
1859	16,131	65,724
1860	16,500	66,000
Total	93,500	£374,000

QUEENSLAND.

This is a comparatively new British colony, and comprises the whole northeastern corner of Australia. Its area is 678,000 square miles, nearly four times as great as that of France. It produces annually a small quantity of gold, and the exports in 1866, as furnished by the customs department, amounted to £85,521, or about $400,000.

The commissioners of the colony exhibited some fine specimens of gold nuggets and gold bearing quartz at the Exposition, the heaviest nugget weighing, originally, 84 ounces, but they were not accompanied by any statistics in detail. According to Dicker's Mining Record of April 17, 1866, there is but one quartz crushing establishment in the colony, and only one quartz mining company at work.

[1] For some later statistics of production, see page 107.

NEW ZEALAND.

Gold was first discovered in New Zealand in 1842, but attracted little attention until 1852, when it was also found in Auckland and Otago. Since then, the known limits of the gold region have been greatly extended by discoveries from year to year up to the present time, and gold is now mined over a vast area in the provinces of Otago, Auckland, Nelson, and Canterbury.

According to the reports and awards of jurors of the New Zealand exhibition, 1865, the amount of gold exported from the province of Otago from 1861 to 1865, inclusive, was 1,699,667 ozs., 7 dwt., 6 gr.

The following table, compiled from the monthly returns of gold exported, and published by Mr. Phillips, shows the quantity and value of gold from the gold fields in each island and the whole of New Zealand, exported from the colony from 1st of April, 1857, to 31st December, 1864. In these returns the value was calculated on the estimated rate of £3, 17*s.* 6*d.* per ounce, with the exception of the gold from the North island.

Exports of gold from New Zealand.

Produce of—	During 1864.		From April 1, 1857, to Dec. 31, 1863.		Total exported from New Zealand to Dec. 31. 1864.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Ounces.		*Ounces.*		*Ounces.*	
North Island	3,448	£10,552	6,076	£19,323	9,524	£29,875
South Island	476,723	1,847,295	1,263,112	4,894,560	1,739,835	6,741,855
Total from New Zealand	480,171	£1,857,847	1,269,188	£4,913,883	1,749,359	£6,771,730

According to the Rev. W. B. Clarke, the rock formations of New Zealand are a repetition in kind of those of Australia. The alluvial deposits are deep and extensive, and similar to the Australian. A large part of the gold is produced by sluicing, and but little attention has yet been paid to working the veins.

If we assume that the production of gold in New Zealand has diminished yearly in the same ratio as that of Victoria, the total product for 1867 was approximately $6,000,000, and this is the amount credited to the colony in the summary of total production of the world, given at the end of Chapter III, and in Chapter VIII.

CHAPTER III.

THE GOLD PRODUCTION OF EUROPE, ASIA, AND AFRICA.

Russian Gold-Field—Production of Different Districts—Total Production—Mines Represented at the Paris Exhibition—Great Extent of the Gold Field—Austrian Gold Production—Spain—Italy—Roumania—France—United Kingdom—Gold Localities in China—Japanese Gold Mines and Exports—Method of Washing—Africa.—Résumé of Total Gold Production.

RUSSIA.

In the Ural mountains vein mining for gold preceded the modern alluvial or placer washing. The existence of gold in these mountains and in the Altai was known to Herodotus, but its rediscovery by the Russians dates from 1743 and 1744, during explorations ordered by Peter the Great. A result of this discovery was the establishment of works for the extraction of the metal from the ores at Woitski in 1745. In the same year work was commenced by the government at Bérésofsk, and this mine has continued in operation until the present time. Its production up to 1853 has been estimated at 10,267 kilograms of pure gold,[1] or about 3,330,258 troy ounces, which, at $20 per ounce, gives the aggregate of $66,605,160

Other veins have been discovered, but have not, in general, been remunerative, and nearly all the gold product of Russia is from placers. Work upon them was commenced by the government in 1814, and from that year to 1820 the production was but slight. According to M. Michel Chevalier[2] the product in 1816 was only 96¼ kilograms of gold, and from 1810 to 1825, only 933 kilograms. This was for the western Uralian gold field only. Gold was afterwards found upon the eastern slope of the chain, and traced eastward into Siberia. The active working of the placers dates from 1829 in western Siberia, and from 1838 for eastern Siberia, where the placers are more numerous and extensive than in the western portions, and, in fact, have an enormous extension eastward to the Pacific coast. According to the official data furnished at the Exposition by the Imperial Commission,[3] the gold washings of the empire are now found upon the eastern side of the Ural mountains, in the governments of Perm and of Orenburg; in the system Sayano Altaique, (governments of Tomsk and of Yenisseisk,) and in the system Yablonnoi

[1] M. Narces Tarassenko-Otreschkoff, De l'Or et de l'Argent, Chapter XI, p. 128; cited by Dalloz, De la Propriete des Mines, II, 329.

[2] Cours d'Econ. Politique, 3d volume, De la Monnaie, section VI, Chapter II, p. 265: cited by Dalloz.

[3] Aperçu Statistique des Forces Productives de la Russie, par M. de Buschen, annexe au Catalogue Special de la section Russie: 8vo; Paris, 1867.

Krëbet, (Transbaicalie.) Under the Administration General of Mines these regions are divided into districts, from each of which the returns of production are separately obtained. The mines are no longer monopolized by the government, but are thrown open to private enterprise, and many of the miners have made large fortunes. The placers appear to be quite equal in richness to those worked in California and Australia. In 1863 the product of these districts was as follows:

Gold washings in Siberia in 1863.

Districts.	Number of washings.	Number of miners.	Product of washings in poods.[1]	Product of washings in kilograms.
			Poods. l.	*Kilog.*
Nertschinsk, (Transbaicalie,) property of his Majesty the Emperor....	4	927	21 15	350.4
Bargousinsk, (Transbaicalie,) private property..........	23	2,447	113 7	1,855.3
Verkné-Oudinsk, (Transbaicalie,) private property..........	9	1,053	263 3	439.8
Olekminsk, (Yakoutsk,) private property..........	26	4,873	185 14	3,038.5
Kansk and Nijne-Oudinsk, (government of Yenisseisk and Irkoutsk,) private property..........	21	1,402	35 27	584.8
Minnoussinsk, (government of Yenisseisk,) private property..........	32	1,667	54 33	898.8
Atschinsk, (government of Yenisseisk,) private property..........	24	786	16 27	273.3
Yenisseisk, (central portion,) private property..........	63	5,878	164 3	2,689.9
Yenisseisk, (northern part,) private property..........	79	9,039	394 0	6,459.0
Marjinsk, (government of Tomsk,) private property..........	81	1,449	25 5	411.9
Altaisk, (government of Tomsk,) private property..........	1	18	0 15	6.1
Altaisk, (government of Tomsk,) property of his Majesty the Emperor.	17	3,243	85 4	1,395.1
Ssemipalatinsk, (washings of Tarbagati,) private property..........	8	1,062	5 38	97.5
Ekatherinburg, (government of Perm,) property of the state..........	35	1,185	40 10	659.8
Goroblagodat, (government of Perm,) property of the state..........	......	......	......	......
Bogosslowsk, (government of Perm,) property of the state..........	38	1,356	25 17	416.8
Zlatoust, (government of Orenburg,) property of the state..........	38	1,586	43 21	713.5
Beresowsk, (government of Orenburg,) property of the state..........	1	67	0 12	4.9
Orenburg and country of the Cossacks of the Ural, private property..	205	10,975	84 18	1,384.4
Perm, washings in, private property..........	39	8,764	136 29	2,313.1
Total..........	745	57,957	1,459 8	23,920.0

The total value of the gold production for the year 1863, calculated upon the price established by the Crown, which buys all the produce of the mines, was 19,307,112 roubles, (77,228,448 francs,) equivalent to about $15,445,669.

The most profitable washings are those of Olekminsk, of Bargousinsk, and of Zlatoust. Those of the Altai come next. No figures of the production of the washings of Goroblagodat have been received since 1861. Its former production was from four to five poods, about 80 kilograms,

[1] The Russian *pood* equals 16.380 kilograms, according to the tables in the official catalogue of the Russian department of the Exposition. Other authorities: M. Tarassenko-Otreschkoff places it as equal to 16.370 kilograms, and M. Le Play, (*Voyage dans la Russie Meridionale,*) at 16 372 kilograms.

or $51,590. In general, the production of gold has not been increasing since 1850, as shown by the following tabular statement of the production for the years stated:

Years.	Product of washings.		Value.	
	In poods.	In kilograms.	In roubles.	In francs.
	Poods. l.			
1830	360 8	5,904.9	4,665,920	18,663,680
1840	567 39	9,311.0	7,515,246	30,060,984
1850	1,453 32	23,872.8	19,235,936	76,943,744
1860	1,457 16	23,891.8	19,283,428	77,133,712
1861	1,456 5	23,870.9	19,265,986	77,063,944
1862	1,460 29	23,946.3	19,318,915	77,275,660
1863	1,459 8	23,920.0	19,367,112	77,228,448

According to Mr. Tarassenko-Otreschkoff,[1] the total production of gold from the commencement of mining, in 1745, up to 1810, a period of 65 years, was 25,537 kilograms, valued at 85,194,720 francs. This is founded upon an estimate of an average annual production of 392 kilograms, value 1,310,688 francs. The same authority gives for the period from 1810 to 1825 an average annual product of 1,095 kilograms—value 3,655,360 francs—and a total during the 15 years of 16,435 kilograms, valued at 54,830,448 francs. In the next period, from 1824 to 1848, the washings of the Ural and of Siberia attained their great development. For these years the following figures have been adopted by M. Michel Chevalier and by M. Tooke, and are cited by Dalloz. The estimates include a small quantity of fine gold taken from silver bars.

Annual production of fine gold from the placers and other sources in Russia from 1824 to 1848.

Years.	According to Chevalier.	According to Tooke.	Years.	According to Chevalier.	According to Tooke.
	Kilograms.	*Kilograms.*		*Kilograms.*	*Kilograms.*
1825	4,764	4,450	1838	9,317	9,07[illegible]
1826	4,811	4,456	1839	9,345	9,084
1827	5,609	5,323	1840	10,288	10,[illegible]
1828	5,766	5,500	1841	12,129	11,7[illegible]
1829	5,722	5,444	1842	16,498	16,441
1830	6,839	6,545	1843	22,214	22,[illegible]
1831	7,043	6,862	1844	22,817	23,2[illegible]
1832	7,389	7,095	1845	23,800	23,97[illegible]
1833	7,281	7,067	1846	28,[illegible]	....
1834	7,222	7,025	1847	30,854	....
1835	7,408	7,144			
1836	7,613	7,371	Total	271,521	[illegible]
1837	8,381	8,120			

Lieutenant General Tchevkine and Colonel Ozersky estimate that the total production of the Russian gold mines for the first half of this cen-

[1] Cited by Dalloz, p. 324.

tury, from 1800 to 1850, was 21,260 poods of pure gold, or more than 340,304 kilograms, of which more than 295,360 kilograms was obtained after the year 1826.[1]

The production of gold from 1847 to 1855 was as follows, according to M. Tarassenko-Otreschkoff:[2]

	Kilograms.
1848	27, 153. 737
1849	25, 074. 747
1850	23, 319. 475
1851	23, 781. 517
1852	21, 673. 880
1853	22, 034. 427
1854	24, 595. 925
Total	167, 633. 708

The following table has been prepared from the various sources cited, and exhibits the total production of the Russian gold mines up to the year 1864. The production for the five years from 1854 to 1860, for which no returns have been found, is estimated to have averaged 23,882.3 kilograms a year, this being the mean of the production for the years 1850 and 1860, according to the official data at the Exposition:

Total production of Russian gold mines to 1864.

Years.	Kilograms.	Value in francs.	Value in dollars.
1745 to 1810	25, 537. 000	85, 194, 720	17, 038, 944
1810 to 1825	16, 435. 000	54, 830, 448	10, 966, 089
1825 to 1848	271, 521. 000	875, 492, 312	175, 098, 462
1848 to 1855	167, 633. 708	539, 518, 128	107, 903, 625
1855 to 1860	119, 411. 500	385, 030, 440	77, 006, 088
1860	23, 891. 800	77, 133, 712	15, 426, 742
1861	23, 870. 900	77, 063, 944	15, 412, 788
1862	23, 946. 300	77, 275, 660	15, 455, 132
1863	23, 920. 000	77, 228, 448	15, 445, 689
Total	696, 167. 208	2, 248, 767, 812	$499, 753, 562

This exhibits a total production of 696,167 kilograms from 1745 to 1864, a period of 119 years; valued at 2,248,767,812 francs, or, at five francs to a dollar, $449,753,562. The average value of the annual production for the last four years given in the table is $15,335,088. It is reported, however, that the production is now increasing, and that in 1864 it was nearly "23 tons," and in 1865 "over 26 tons." It may, therefore, be safely estimated that the total production of gold in Russia up to the year 1868 was over $525,000,000, stated in round numbers.

[1] Extract from the Jour. des Mines de Russie in the Annales des Mines, 5 serie, t. 3, p. 801. Cited by Dalloz, ii, 337.

[2] Cited by Dalloz, ii, 338.

The following table gives the production of the Russian mines from 1814 to 1859, inclusive, in troy pounds, according to Tschewkin:[1]

	Troy pounds.
1814 to 1820	11,085
1820 to 1830	73,200
1830 to 1840	175,460
1840 to 1850	553,955
1850 to 1860	687,025
Total in troy pounds	1,500,725

Nearly the whole of this product is obtained from washing, very little, as before stated, being from veins. The most productive placers are in the districts of Olekminsk, Bargousinsk and Zlatoust. Those of the Altai are next in importance. The placers found upon many of the tributaries of the Amoor, and many places within the limits of the governments of Irkoutsk and the province of Yakoutsk, are regarded as exceedingly promising.

The gold districts and washings specially represented in the Exposition were as follows:

Mines of the Altai.—Government of Tomsk, districts of Biysk, of Kouznetzk, and of Barnaoul, by the Administration of the Mines of the Altai. (Catalogue Special, 433.)

Iagodni (or Yagodny) mines.—Government of Perm, district of Ekatherinburg, by Benjamin Astacheff. (Catalogue Special, 438.)

This exhibit contained a nugget of gold in quartz, weighing 3½ *livres*,[2] (about 3 pounds avoirdupois,) and one from the government of Yenissesk weighing 6 livres; a sample of pure gold in powder, and a view of the gold workings and aqueducts of Yagodin. This view is accompanied by an explanation which states that the mines are upon the east slope of the Ural mountains, under the superintendence of Mr. Focht. The auriferous gravel is about 72 feet deep, and it is worked in an open quarry by a system of terraces or underhand stoping. The "pay" appears to be disseminated throughout the mass, for it is all removed. It is loaded in one-horse carts which rise an inclined plane or corduroy roadway, and take the gravel to mills or machines for washing. This exploitation was commenced in 1862, and the production of gold has varied from 14 to 18 poods per annum, valued at 200,000 roubles, (800,000 francs,) about $160,000. The washing machines are driven by steam, and 400 workmen are employed.

Miask gold mines.—Government of Orenburg, district of Troitsk:

1. Specimens of the earth and rocks found above and below the pay gravel of the mines of Andreeisk and of Miask.

2. Specimens of the pay gravel.

[1] Tschewkin, Jour. des Mines, quoted in Ann. des Mines, (5,) III, p. 805. Archiv. fur wissenschaftliche Kunde von Russland, 1865, p. 397; cited by Phillips, Met. Gold and Silver, p. 24.

[2] One livre = 0.41 kilogram.

3. Specimens enriched by washing.

4. Black sand and gold from washings.

This placer was discovered in 1823. In 1863, 27,000,000 of poods of auriferous sand and gravel had been washed.

Temissei.—District of——. Nuggets of gold, black sand, and pay gravel, by Michel Sideroff. (Cat. Spec., 508.)

Taguil.—Government of Perm; specimens of the gold and alluvia from the mines of Paul Demidoff, (exhibitor.)

These gold washings have produced, since 1823, nearly 1,155 poods of gold, and the washings of platina (see "Platina") have yielded nearly 3,105 poods of this metal since 1825. 107 gold placers or washings, and 20 of platina, have been discovered upon the property of this exhibitor.

GENERAL OBSERVATIONS UPON THE RUSSIAN GOLD FIELD.

The exhibition made by Russia also contained some very interesting models of machines used for washing auriferous sands and gravels on a large scale, now much used in the Russian and Siberian gold fields. It seems probable that, the climate permitting, the American methods of washing might be advantageously adopted there.

There have been various estimates made of the richness of the aurifeous gravels and sands, &c., of the Russian mines, but it is evident to any one practically familiar with gold washing operations on a large scale, that it is exceedingly difficult, if not impossible, to arrive at any general conclusion regarding the quantity of gold contained in placers. Scarcely any two deposits are alike in the ratio of gold to the alluvia.

According to Chevalier,[1] in the washings of the Ural, before they were extended eastward, the yield in gold was from two to two and a half millionths of the weight of the earth washed. M. Tarassenko-Otreschkoff cites gold mines belonging to the Crown in the Urals, where the average yield was two grams, 3.37 grains, and six grams to the 1,637 kilograms of earth washed. In the placers of the Altai, washings have been found that have given regular returns two, three, and four times as great as the average of the placers of the Ural. M. Tarassenko-Otreschoff states that the auriferous deposits of the governments of Tomsk and of Yenisseisk contain on an average from four to eight grams of gold to 1,637 kilograms, as washed. Some produce only from two to three grams. The deposits of eastern Siberia are richer than those in western Siberia and the Urals. The same authority estimates the yield of the washings in the Kirghese district at two grams to 1,637 kilograms. It is stated in the Annales du Commerce Intérieur that in the year 1852 61,232 grams of gold were extracted in the Kirghese districts from 5,416,800 poods (88,627,184 kilograms) of gravel.

According to Phillips the gold-bearing veins of the Berezofsk mine are generally small, and traverse a sort of decomposed granite which itself traverses talcose, chloritic, and micaceous shales in the form of

[1] Page 268, cited by Dalloz, p. 333, chap. XII; § 6, p. 156, cited by Dalloz.

veins or dikes. The most productive veins are quartz, cutting the granite at right angles. This mine formerly yielded from 600 to 800 pounds of gold annually, but the production had decreased to 100 pounds in 1850. During the period of greatest success the yield per ton of stamped ore was from 6 to 11 dwts.

At the Soimanofsk mines, north of Miask, there are placer deposits of gold upon the rough decomposed surface of limestone, closely resembling the placers in the vicinity of Murphy's, Calaveras county, California,[1] where, as in Russia, the remains of the mammoth and the mastodon are found in the gravel with the gold. From one of the placers, near Miask, a nugget of gold was taken that weighed 97 pounds troy,[2] and is now in the museum of the Imperial School of Mines at St. Petersburg.

The Uralian and Siberian gold field is, perhaps, the most extensive on the globe, stretching, as it does, along the Ural, and to the eastward through Siberia to the Kamtschatka and Ouskoi mountains bordering the Pacific ocean, a distance, as remarked by Chevalier, "which embraces the half of a circle which would be described in making the circuit of the globe on these latitudes." The auriferous deposits are there distributed in numerous groups and over a large surface, and the zone over which they are spread is of an average width of about 550 miles.

It appears that these Siberian gold deposits were known and worked, at least in part, at a very remote period, for abandoned workings have been found at many points, and are known among the Russians as *puits finnois*, which, if not made by the ancient Scythian tribes, as is probable, at least belong to an epoch anterior to the conquest of Siberia by the Tartars 2,000 years ago.[3]

These ancient mines have been traced by Gmelin, Lepechin, and Pallas, on the southern and eastern borders of the Ural mountains. The only tools found in the old pits were wedges and hammers made of copper, and heavy sledges made of stone, with grooves by which handles appear to have been attached. The tusks of boars appear to have been used to scrape out the gold, and some leather bags have been found. Numerous fragments of earthenware are found to a great distance around the ruins, and in some places human bones have been discovered in the old passages and galleries, appearing as if the mines had caved in upon the miners. The ores raised at some of these mines were smelted in rude furnaces.[4]

The Uralian and Siberian gold regions have been visited and described by several eminent geologists. Baron Humboldt made an extensive journey there in 1829, at the request of the Emperor Nicholas, and obtained the materials for his great work on Central Asia; and, later, Sir Roderick I. Murchison made explorations in the Urals, an account of which is given in his work entitled "Russia in Europe and the Urals." Much information upon the Russian mines is also given in the "Annuaire des Mines de Russie." The production of gold in these regions has been

[1] Geological Reconnaissance in California, p. 256.
[2] Dalloz, ii, 330.
[3] Siluria, p. 484.
[4] Jacob on the Precious Metals, i, 39.

retarded to a great extent by the control exercised over them by the government, and the imposition of heavy taxes. In 1849, the Emperor Nicholas, by the edict of 14th (26th) of April, subjected mining operations to a progressive tax, which, for such enterprises or claims as yielded upwards of 40 poods of metal, (655 kilograms, or 2,170,000 francs, about $434,000 in value,) amounted to from 30 to 35 per cent. upon the gross product. This was also independent of a special tax for police purposes, which amounted to about $8 upon every pound of gold of the mint standard.[1]

AUSTRIA.

The production of gold in the Austrian empire is chiefly from Transylvania and Hungary, and reached the amount of 1,824 kilograms (58,672 ounces troy) in 1865. At the Exhibition of 1862 it was stated that the production amounted to about 3,200 pounds troy annually. The gold is obtained from ores of low percentage, from veins which formerly were supposed to traverse the oldest rocks, but these rocks have been proved to be of the latest Secondary, or even Tertiary periods.

According to Dalloz[2] the production of gold has been increasing since 1772. From 1825 to 1848 the average annual product was 1,700 kilograms; and in 1855, according to M. Otreschkoff,[3] it was 2,013 kilograms, valued at 6,750,000 francs.

M. Callon has published in the "Annales des Mines" for 1861 extracts from the statistical publications of M. de Carnall, from which, and from the official documents published by the Austrian minister of finances, the following figures are taken:[4]

	Kilograms.
1855	1, 478. 454
1856	2, 912. 850
1857	2, 722. 400
1858	2, 470. 450
1859	1, 646. 627

All the preceding statistics differ somewhat from the following, compiled for the writer, from official sources, at the Exposition:

Annual production of gold in the Austrian empire from 1819 *to* 1865, *inclusive.*

Year.	Kilograms.	Year.	Kilograms.	Year.	Kilograms.
1819 to 1828, about	1, 105	1853	1, 766	1860	1, 596
1829 to 1838, about	1, 514	1854	1, 788	1861	1, 588
1839 to 1848, about	1, 729	1855	1, 733	1862	1, 700
1849	14	1856	1, 635	1863	1, 514
1850	1, 648	1857	1, 528	1864	1, 799
1851	1, 919	1858	1, 387	1865	1, 824
1852	1, 676	1859	1, 647		

[1] *Vide* Chevalier on Gold, Cobden's translation, pp. 82–83.
[2] De la Propriété des Mines, ii, p. 291. [3] De l'Or et de l'Argent, i, pp. 104, 108.
[4] Cited by Dalloz, vol. ii, p. 292.

The production of gold ores for the three years ending in 1866 was a follows:[1]

Years.	Vienna centners.[2]	Value in florins.	Value in dollars.
1863	132,963	292,598	$146,30
1864	159,485	432,666	218,83
1865	162,303	320,266	160,23

SPAIN.

Gold and silver mines have been worked in Spain from very remote periods. Both Strabo and Pliny mention the abundance of the precious metals in the peninsula, and state that Hannibal would not have had the means of continuing the war in Italy except by the discovery of many mines of gold and silver in the province of Carthagena. According to M. Boekh these mines yielded 6,500 kilograms of fine gold during the time of the Romans. The gold mines were also worked by the Moors.

The present production of the country is exceedingly small, probably not over $6,000 to $8,000 in value annually. The data furnished by the Royal Commissioner at the Exposition show an annual production of 7,660 grams, valued at "9,958.800 *écus*," (probably $14,500,) but the source is not stated.

ITALY.

The mineral collections from Italy in the Exposition contained some specimens of the gold ores of the country and some remarkably fine masses of crystalline gold, in regard to which no information could be obtained.

The gold localities of Italy were well known to the ancients, and, according to Strabo, the production at one time was so great that the value of the metal in Italy was reduced one-third.[3]

The gold of Italy is obtained from the auriferous pyrites of the Alps; the auriferous quartz of the Ligurian Appenines, in the valleys of Anzasca, of Antigario, and from the sands brought down the beds of the Orco, the Tessin, the Po, and the Serio. The amount so obtained was estimated in 1862 at 3,200 ounces annually, from the veins, and only about 300 ounces from the placers. The total production at the present time, in the valleys named, is valued at about 500,000 francs. There are nine mines which are now worked, three of which have amalgamating mills. Five of these mines have produced 94 kilograms of gold, valued at 22,655 francs. There are 610 workmen, and their wages amount to 256,600 francs annually.[4]

According to Phillips[5] the only gold mines of consequence at the present time are in Savoy and Piedmont. It is extracted from the valleys of

[1] Der Bergwerks-Betrieb fur das Jahr 1865: Vienna, 1867.

[2] One Vienna centner equals 56.00199 kilograms; one florin equals 2.5 francs.

[3] Strabo, lib. iv, cap. 6. [4] Italie Économique en 1867: 8vo.; Florence, 1867.

[5] Metallurgy of Gold and Silver, p. 20.

Anzasca, Toppa, and Antrona, and in smaller quantity in those of Alagna, Sesia, and Novara. The principal mines are at Peschiera, and Minera di Sotta, Anzasca. The ore is an auriferous pyrites, containing an average of about 12 pennyweights of gold per ton.

In 1844 the yield of the different valleys was as follows:

Name.	Kilos.	Value.
Anzasca	153.	$80, 460
Toppa	19.	10, 160
Antrona	20.	10, 750
Alagna, Sesia, and Novara	....	1, 250
		$102, 620

The development of some of these Italian mines has recently been undertaken by English companies, and Mr. Phillips gives in the appendix to his work some of the first returns, supplied to him by Mr. J. C. Goodman, as follows:

Toppa Gold-mining Company.

Year.	Ounces.	Value.		
1864	509. 275	£1, 798	18	09
1865	574. 575	2, 032	14	05
1866	1, 400. 925	4, 927	15	08
	2, 869. 050	£8, 789	08	10

The ore has averaged 1 ounce 5 pennyweights of gold per ton.

Anzasca Gold-mining Company.

Year.	Ounces.	Value.		
1864	381. 650	£1, 105	14	10
1865	740. 475	2, 291	14	09
1866	1, 746. 925	4, 966	16	03
Yield since 1863	2, 869. 050	£8, 364	05	10

Pestarena Gold-mining Company.

Year.	Ounces.	Value.		
1866	2, 806. 500	£9, 125	17	09
1867, (to July)	2, 729. 775	8, 669	14	00

The ore of this mine has yielded 2½ ounces per ton. The rocks which the veins traverse are composed of micaceous and talcose slates, belonging probably to the Silurian period. The veins are numerous, and are sometimes as much as three feet in thickness, containing a mixture of iron and sometimes of arsenical pyrites, with strings of quartz and spots of galena. The shafts in 1862 had been sunk to a depth of about 500

feet, and the workings extend horizontally for more than three-quarters of a mile.[1]

The foregoing data show that the total yield of all these mines for the year 1866 was £19,050, or about $95,250.

ROUMANIA.

Some very coarse alluvial or placer gold was exhibited from this region, but no information in detail of the extént of the deposits, or of the production, could be obtained. Gold is found in most of the rivers flowing from the Carpathian mountains in this Principality, but chiefly in the Olto, the Ardgèche, and their branches. These deposits were formerly worked by state slaves, and the proceeds belonged to the reigning princesses. A very few persons are now engaged in washing on their own account.

Vein gold is found in the mountains of Ardgèche, Rucar, Tergoviste, Bacau, Niamtzo, and of Suciara. The quartz veins of Pazra contain chalcopyrite, auriferous iron pyrites, and argentiferous galena.

FRANCE.

A gold-bearing vein was formerly worked at La Gardette in the department of the Isère, but it did not pay expenses and was abandoned in 1841, after having been worked at intervals since 1700.

A small amount of alluvial gold is found in the sands of the Rhine, but the production is insignificant. According to M. Daubrée, who made a report upon the gold deposits of the Rhine to the Academy of Sciences,[2] the production for the year 1846 was estimated at about $9,000, and the washers usually made from one and a half to two francs a day. Since that time the production from the Rhine has greatly decreased, being only 1,300 grams in 1853, and worth about 4,446 francs. The production from other sources, chiefly from auriferous galena, and the cinders and refuse of jewellers, has been increasing, as will be seen by the following statement, showing an average production of about $82,000 in value, annually.[3]

Production of gold in France.

Year.	Weight.	Value.	Year.	Weight.	Value.
	Grams.	*Francs.*		*Grams.*	*Francs.*
1853	120,200	411,944	1858	95,660	326,108
1854	156,900	538,000	1859	76,600	262,640
1855	240,284	823,045	Total	837,987	2,868,443
1856	72,663	247,010			
1857	75,680	259,696			

[1] Kingdom of Italy, International Exhibition of 1862.

[2] Compte Rendus, xxii, 639; 1846.

[3] Compiled from the official tables in the Resumé des Travaux Statistiques for 1860.

GREAT BRITAIN AND IRELAND.

The following notices of the auriferous localities of the United Kingdom are condensed chiefly from the recently published work of Mr. Phillips.

Gold has long been known to exist in Cornwall in small quantities in the stream gravel, with tin-stone, and in minute quantities in many of the copper gossans.

In Wales there is a gold-bearing district about 25 miles square, and, according to Mr. Arthur Dean, there is a complete system of auriferous veins throughout the whole of the Snowdonian or Lower Silurian formation of North Wales. Of all the veins that have been worked in the neighborhood of Dolgelly, the Vigra and Clogau has been the most productive. This mine is about 1,000 feet above tide. The vein is nearly vertical, runs east and west, and is formed of quartz impregnated with sulphides of iron, lead, and copper. It sometimes shows free gold.

The following table, exhibiting the returns from the various Welsh gold-mines from 1860 to 1864, the time of their greatest yield, was furnished to Mr. Phillips by Mr. Robert Hunt, keeper of mining records:

Gold produced in Merionethshire.

Mines.	1861.		1862.		1863.		1864.	
	Oz.	£.	Oz.	£.	Oz.	£.	Oz.	£.
Vigra and Clogau	2, 886	10, 816	5, 299	20, 390	526	1, 674	2, 331	3, 434
Cefn Coch					25	73	346	970
Castell Carn Dochan							141	394
Prince of Wales							63	166
Gwyn-fynydd							6	17

The number of tons of quartz crushed in Wales, during the year 1865, is reported as 4,270, yielding 1,664 ounces of gold, about 0.39 ounce per ton. The total yield of gold in the North Wales district, up to April 1, 1866, is estimated as follows:

	Ounces of gold.
Old Dol-y-frwynog	117
Prince of Wales	63
Cwn Eisen	176
Gwyn-fynydd	6
Cefn Coch	478
Castell Carn Dochan	182
Vigra and Clogau	11, 778
	12, 800

The volume of Mineral Statistics of the United Kingdom for 1866 recently published, gives the following returns of Welsh gold for 1866

Mines.	Gold quartz.			Gold.		
	Tons.	*cwt.*	*lbs.*	*Ozs.*	*dwt.*	*gr.*
Vigra and Clogau	1,159	19	8	213	14	[illegible]
Castell Carn Dochan	1,768	0	0	529	1	[illegible]
Total production for 1866	2,927	19	8	742	16	[illegible]

This added to the previous production gives a total of 13,542 ounces the value of which may be estimated at about $243,000.

In Scotland gold was formerly found at Lead Hills, and several hundred men were employed there during the reign of James V.[1]

In Ireland, gold was discovered in 1796, in the county of Wicklow, at the base of Croghan-Kinshela. Washing continued for two years but the results do not appear to have been satisfactory. One specimen weighed 22 ounces. The locality is now abandoned.

CHINA.

A table of localities of gold washings and mines in the Chinese empire, published in the recent work of Mr. R. Pumpelly,[2] shows that the gold regions are extensive, as there are numerous localities of the metal in no less than 14 out of the 18 provinces of the empire. The greatest number of washings are in the province of Sz'chuen, and along the branches of the Kwenlun mountain chain, which have a general east and west trend, and penetrate far into central China, between the Wei river and the Sz'chuen boundary. They are numerous also at the base of the water-shed between Kweichau and Hunan, and through the centre of Shantung, from southwest to northeast. Most of the localities mentioned furnish coarse placer gold, and some of them are mentioned as rich, and as furnishing nuggets. Little or nothing is known, however, of the production of these washings, which may long since have been exhausted. The country has long been known to have extensive sources of gold, but it is said that the working of the mines has been discontinued by the Chinese government in accordance with some of their theories of finance. The extensive auriferous regions of the Altai and other mountain ranges of eastern Siberia are doubtless prolonged into Chinese Tartary, and connect with those of central and southern China. Unless the exhaustion of these placers and veins has been greater than the imperfection of ancient methods of working allows us to suppose, this region, together with the Siberian, is now doubtless the greatest and richest gold-field which remains for exploration.

[1] Pennant's Scotland, ii, p. 130, quoted by Phillips.

[2] Geological Researches in China, Mongolia, and Japan, during the years 1862 to 1865, by Raphael Pumpelly, Smithsonian Contributions; Washington, 1866.

Mr. S. Wells Williams states[1] that gold is brought into China from Borneo and California as dust and in impure masses, (1854.) The importations at that date had reduced the relative values of gold and silver to the ratio of 1 to 14½.

The exports of bullion (gold and silver) from California to China have steadily increased from $965,887 in value in 1854 to $6,527,287 in 1866, and to $9,031,504 in 1867. (*Vide* table, Chapter I.)

Gold leaf or heavy foil is used in China in making payments not less than $40 to $50. Thin gold leaf is largely used there for gilding the wood-work of houses, and quantities were formerly exported to India.

JAPAN.

It was the reported richness of the empire of Japan in gold and silver which drew thither the early Portuguese and Dutch traders. All the early accounts of the country agree respecting the abundance of the precious metals, and they were fully sustained by the results of the Dutch trade. The annual average sales by the Dutch amounted to the value of 60 Dutch tons of gold,[3] and in one year they reached the amount of 80 tons, about $3,200,000. Among their exports were 1,400 chests of silver, (each containing 1,000 taels,[4]) or near $2,000,000 in all. This constant drain of silver appears to have excited the alarm of the Japanese, and gold was partly substituted in trade, until at length the exportation of this metal was also restricted. Its value, relatively to silver, has always been less in Japan than in other countries, and this alone has led to a large export, and with great profits. In the two years, 1670 and 1671, more than one hundred thousand kobangs[5] ($1,100,000) were exported at a profit of a million florins,[6] ($400,000.)

According to Arrai Tsikugo-no-Kami, a learned Japanese of rank, who published a tract on the "Origin of the Riches of Japan" in 1708,[7] the amount of gold and silver exported from Nagasaki from 1611 to 1706 was as follows:

	Value.
Gold, 6, 192, 600 kobangs	$68, 118, 600
Silver, 12, 1268, 700 taels	157, 176, 180
Total	$225, 294, 780

[1] Chinese Commercial Guide, 4th edition, p. 175. [2] Ibid.

[3] A Dutch ton of gold was 100,000 florins or $40,000. See Hildreth's "Japan as it is and was," p. 208.

[4] Hildreth, Ibid, 208. The *tael*, reckoning the picul at 133⅓ pounds avoirdupois, contains 583 grains troy. The tael is, therefore, worth about $1 40. Kaempfer considered it worth 3½ florins, which, at 40 cents to a florin, makes the value exactly $1 40.

[5] The kobang is a gold coin, which, at that time, weighed 47 kanderins, or 274 grains troy, or 16 grains more than our eagle. It, however, contained only 224 grains of gold, worth, say, $11. It was purchased by the Dutch for six taels, or less, in silver.

[6] Hildreth, Ibid, p. 209.

[7] Ibid., 385, translated by Klaproth, Noveau Journal Asiatique, ii.

Hildreth further observes that the value of the export of the precious metals from Japan in the course of 200 years, from 1540 to 1740, must have been not less than $200,000,000.

This disproportion between the value of gold in Japan and other countries existed at the time of the visit of Commodore Perry, and the first traders made large profits by the wholesale purchase and export of the gold kobangs. A letter from the United States consul general (Mr. Harris) at Simoda, in 1857, stated that the relative values of gold and silver in Japan were as one to three and one-seventh. To avoid the great drain of gold which followed the discovery of this disproportion in the relative value of these metals, the size and weight of the gold coins were further reduced by the Japanese government.

Gold is largely used in Japan for gilding, for inlaying and overlaying metals, and for alloys with copper and silver of various colors and degrees of fineness. The first discovery of the metal in Japan is said by Sir Rutherford Alcock to date from half a century later than the first coinage in 708.[1] Before this time gold was imported from China. Arrai Tsikugo-no-Kami[2] is the authority for the statement that the first gold coins were struck by Taiko-Sama. It seems probable, however, that gold was known in the country long before.

GOLD MINES OF YESSO AND SADO.

One of the earliest reports of gold mines was made by Father Jerome de Angelis, who visited the island of Yesso in 1620, and sent home glowing accounts of its riches in gold-washings.

The gold deposits of this large island were visited and surveyed in 1862 by the writer, together with Mr. Pumpelly, while in the service of the Tycoon's government. These gold mines are government property, and are worked on a limited scale. The gold region extends along the Kunui and Tusibets rivers, and in the range of mountains dividing Volcano bay from the west coast. There are also deposits in the territory of the Prince, or Daimio, Matsmai, and probably in the northern portions and interior of the island, as yet but little known, even to the Japanese. The government works consist merely of washings, no veins having yet been found, and the annual product cannot exceed $25,000 at the highest estimate. The gold is in fine scales, and occurs in the gravel of the flats and bars along the streams, resting upon the bed-rock exactly as in other gold regions. The river drift is coarse and heavy, and the deposits are deep. The gold is also found in high terrace deposits on the hill-sides, where the drift is also very coarse and heavy and the gold coarser than in the river. In some of the fine placer gold from this region the writer found a very fine but heavy white sand, consisting of minute white zircons, similar to some found in the gold region of North Carolina. Not only these deposits, but the best of the lower placers, have been worked over by miners of whom there does not appear to be any

[1] Origin of the Riches of Japan, translated by Klaproth, Noveau Journal Asiatique, ii.
[2] Three years in Japan, American edition, ii, p. 347.

history, although some of the Japanese think that the work was done by some of the former heads of the house of Matsmai, some 300 years ago. The trees standing in the old pits are at least of that age. To work these old placers, ditches were cut for many miles, exactly similar to those in use in California, and the deposits appear to have been very systematically and thoroughly washed.

The present system of washing is by a kind of ground sluicing, aided by straw mats, upon which the pay gravel is drawn by the workman with a hoe, and the current washes off the lighter sand and gravel, leaving the gold upon the mat. No board sluices, toms, or quicksilver were used, and these American adjuncts of placer mining were introduced there for the first time in 1862.

There are no doubt gold-bearing veins at the head-waters of the streams, but the dense growth of the cane, or dwarf bamboo, of the country rendered explorations, without cutting roads, almost impossible.

Gold also occurs in other parts of the empire of Japan, but it is difficult to obtain any precise or satisfactory information about the localities. On the islands of Sado, off the northwest coast, there are extensive mines upon a large vein of mixed silver and gold ore, very closely resembling the best of the ore from the Comstock vein, Nevada. This locality has evidently furnished a large amount of the precious metals, but the facts regarding it are very jealously guarded by the Japanese.

Some of the placer gold of Japan was represented in the miscellaneous collection of Japanese minerals at the Exposition.

COCHIN-CHINA, INDIA, AND OTHER COUNTRIES IN ASIA.

Gold is reported to exist in the sands of the rivers of Cochin-China, and to be extremely pure, but the working of the mines was formerly prohibited.

THIBET.

Gold exists in Thibet, but the mines are the exclusive property of the government. The total production was estimated by Jacob, in 1831, at certainly not over 10,000 ounces annually.

INDIA.

Over 12,000 persons are said to have formerly been engaged in gold washing in Assam, and the production amounted to 30,000 ounces annually. A mine called Pakergusi, at the junction of the Brahmapootra with the Dontriri, is said to have been worked for a short time each year, and 1,000 men were employed.[1] Gold has been procured from the coast of Malabar, and in the country to the west and southwest of the Neelghery mountains. According to Mr. Baber, who gave evidence on the subject before the British House of Commons, the auriferous district extends over 2,000 square miles. It was but slightly worked, and only by slaves.

CEYLON, SUMATRA, BORNEO.

Ceylon is said to have formerly yielded considerable gold, but in 1830 the production had ceased. In Sumatra gold is not only found in the

[1] Jacob, ii, p. 330.

streams, but in veins in the mountains of Monangkabo. Jacob (1831) states that the several districts of the island were reported to produce about 13,000 ounces of gold, 19 carats fine. Most of this was used for ornamental purposes, chiefly for gilding.

In Borneo an abundance of gold has long been known to exist. It was obtained chiefly by Chinese and natives, from placer deposits, in a district between Samboss and Pontiana. The number of Chinese so employed was estimated at about 9,000 previous to 1831. The production from that district was estimated at over 88,000 ounces annually, and from the whole island at 120,000 ounces.

According to Kloos[1] the metal is spread in greater or less quantity over the whole island. Upon the borders of the river Kapoea placer gold is found associated with iron ores, sulphuret of antimony, and diamonds. Near Boedoek gold-bearing quartz veins traverse argillaceous schist. The metal is associated with pyrites and with tellurium. A vein of such ore, nearly vertical, and over six feet thick is worked near Montrado. Gold is also found at Kattoe-Koladi, in a clay filling the cavities of limestone. At Janah-Laute the gold is associated (in a placer) with platinum and osmiridium.

CELEBES AND THE PHILIPPINE ISLANDS.

Gold is found in the beds of the rivers of Celebes, and formerly 10,000 ounces were produced each year. The Philippine islands formerly yielded about 15,000 ounces of gold annually.

Jacob, from whose work most of the foregoing notes upon the production of gold in the East Indies are taken, estimated (1831) the total annual production of Asia, including China and Japan, at not over 380,000 ounces of gold and 260,000 ounces of silver, and valued it at about £1,300,000 sterling.

In the 20 years from 1810 to 1829 the treasure, chiefly gold, sent from Europe to India amounted to £7,314,388 sterling.

AFRICA.

According to Russegger, who travelled through Nubia in 1838, the mountain chain which stretches across the interior of Africa from east-northeast to west-southwest, and the streams which flow from it, are auriferous. In Sennaar and southern Abyssinia gold occurs in placer deposits and in quartz veins traversing granite, gneiss, and chloritic slates.

The mines of Bambouk, south of the Senegal, are considered as the most important of Africa, and are the source of the greater portion of the gold which reaches the coast. Another gold district is at Kordofan, on the upper Nile, between Darfour and Abyssinia. Gold is also collected in small quantities opposite Madagascar. Jacob states that there is no

[1] Berg und Hüttenm. Zeitung, 1865, p. 283, noticed by Delesse, Annales des Mines, vol. x, 1866, p. 594.

way in which an accurate estimate can be formed of the gold produced in Africa, and at that time he regarded the accounts furnished by the late African Company as the best available information. These included statements of the gold taken to England by ships of war, which conveyed the largest portion, on account of the greater security and lower rates of insurance. From this source it appears that the whole quantity so imported from the year 1808 to 1818, inclusive, amounted to 81,905 ounces. Of this, 51,569 ounces were valued at £205,344, and in the following four years of peace 30,569 ounces, valued at £125,380.[1]

The existence of an extensive gold field in South Africa has recently been announced. It is said to be in the Moselikatze country, about 700 miles from Durbau, the port of Natal.

Birkmyre estimates the annual production of gold in Africa at 4,000 pounds. Dusgate places it at 3,744 pounds.[2] If we accept the former estimate, and consider the gold worth between $18 and $19 per ounce, the value of the production is about $900,000 annually.

RÉSUMÉ OF THE TOTAL PRODUCTION OF GOLD IN THE YEAR 1867.

The value of the present total production of gold is shown approximately by the following tabular statement. The statistics of the principal gold-producing regions have been obtained up to 1867. Those from California and other portions of the United States include the returns to 1868. In many cases where the returns from several countries could not be obtained up to 1867, the average production at the date of the latest returns has been taken as the basis of an estimate of the production at the present time. Thus, no returns of the production of New Zealand have been received for the years since 1864, and its yield for 1867 is estimated at $6,000,000. In respect to the colony of New South Wales, noticed on page 87, some later returns have been received, and they appear to give the exports of *uncoined* gold, while the table on page 87 includes the shipments of coin. The last received table is annexed, and has been used as the basis of estimate of the yield of the colony for 1867:

Exports from New South Wales to 1867.

Year.	Exportation.	Year.	Exportation.	Year.	Exportation.	Year.	Exportation.
	Ounces.		*Ounces.*		*Ounces.*		*Ounces.*
1851	161,880	1855	107,250	1859	293,574	1863	422,722
1852	199,500	1856	134,950	1860	355,328	1864	314,351
1853	173,960	1857	148,126	1861	403,139	1865	279,121
1854	148,900	1858	255,535	1862	584,219	1866	235,893

[1] Jacob on Precious Metals, ii, 326.

[2] Cited by Phillips, p. 28.

In the following table it appears that the total gold product of the world, for the year 1867, was approximately $130,680,000. The last column shows the ratio of the production of each country to the total production. Thus, the United States produced nearly 43 per cent., Australia 23.78 per cent. and Russia 11 per cent. of the whole.

Approximate statement of the value of the production of gold in the principal gold-producing countries, (1867.)

Countries.	Value of production.	Totals.	Ratio per cent.
NORTH AMERICA.			
UNITED STATES.—California	$25,000,000		
Nevada	6,000,000		
Oregon and Washington	3,000,000		
Idaho	5,000,000		
Montana	12,000,000		
Arizona	500,000		
New Mexico	300,000		
Colorado	2,000,000		
Utah, Appalachians, and other sources, (estimated)	2,700,000		
		$56,500,000	43.23
BRITISH POSSESSIONS.—British Columbia, (estimated for 1867)	2,000,000		
Canada and Nova Scotia, ($551,000)	500,000		
		2,500,000	1.96
MEXICO, (estimated)	1,000,000		
		1,000,000	.76
CENTRAL AMERICA, SOUTH AMERICA, AUSTRALIA, AND NEW ZEALAND.			
SOUTH AMERICA.—Brazil, (estimate, based partly on returns for 1866)	1,000,000		
Chili, (estimated, in part)	500,000		
Bolivia, (estimated 1,600 lbs. troy,) about	300,000		
Peru, (estimated 2,400 lbs. troy,) about	500,000		
CENTRAL AMERICA.—Venezuela, New Grenada, Central America, Cuba and San Domingo, (estimated)	3,000,000		
		5,300,000	4.05
TRALIA.—Victoria, (1,392,336 ozs. in 1867)	26,510,000		
New South Wales, (estimate based on reported production of 235,893 ozs. in 1866)	4,500,000		
South Australia, (estimate based on returns for 1860)	140,000		
Queensland, (1866,) about	400,000		
		31,550,000	24.14
NEW ZEALAND.—(1864, $9,000,000. Estimated for 1867)	....	6,000,000	4.59
EUROPE, ASIA, AFRICA.			
Russia, (estimate based on average of 4 years, 1859 to 1864)	....	15,500,000	11.87
Austria, (1865)	1,175,000		
Spain, (estimated)	8,000		
Italy, (1866)	95,000		
France,[1] (in 1846 about $9,000)	80,000		
Great Britain, (about)	12,0 0		
Africa, (estimated)	900,000		
		2,270,000	1.74
Borneo and East Indies, (estimated)	....	5,000,000	3.83
China, Japan, Central Asia, Roumania, and other unenumerated sources, (estimated)	....	5,000,000	3.83
Total	....	130,680,000	100.00

[1] In part from jewellers' sweepings and refuse materials.

SILVER.

CHAPTER IV.

SILVER REGIONS OF THE UNITED STATES.

STATE OF NEVADA—EXTENT OF THE SILVER REGION AND TOTAL BULLION PRODUCT—PRINCIPAL DISTRICTS—COMSTOCK LODE—LIST OF CLAIMS—MACHINERY—COST OF MATERIALS—EXPENSES AND PRODUCTS OF THE GOULD AND CURRY MINE—AVERAGE YIELD OF ORES—PRODUCTION OF BULLION—REESE RIVER REGION—PRODUCTION OF MINES—EASTERN NEVADA AND DISTRICTS—CORTEZ DISTRICT—NYE COUNTY—ESMERALDA COUNTY—TABULAR STATEMENT OF THE RESULTS OF THE ASSAYS OF ORES SENT TO THE PARIS EXHIBITION—CALIFORNIA SILVER DISTRICTS—IDAHO—COLORADO—ARIZONA AND NEW MEXICO—ATLANTIC PORTION OF THE UNITED STATES, AND LAKE SUPERIOR.

STATE OF NEVADA.

The State of Nevada has an area of nearly 100,000 square miles, extending from longitude 37° to 43° west from Washington, and between the parallels of 37° and 43° north. The presence of veins of silver throughout this vast territory was comparatively unknown eight years ago, when, in 1859, the Comstock vein was discovered. The region was then regarded as an irredeemable wilderness, a land of deserts and death, over which the early pioneers had passed as rapidly as possible in the tide of emigration to the gold regions of California. The scene has changed. Nevada, from a comparatively unknown portion of Utah, became first a Territory and then a State in the Union. It has now a large population, and its principal centres are Virginia City, Austin, Carson, Aurora, and Dayton. The valleys and deserts resound with the shrill whistle of engines and the falling of stamps. The little valleys are brought into cultivation; graded roads are made over apparently impassable mountains; mails arrive and depart daily, and the telegraph connects the business centres with those on the Pacific and the Atlantic. All this has resulted chiefly from the discovery of the celebrated Comstock lode, which has already added nearly $80,000,000 in value to the bullion of the world.

From the Comstock the explorations extended in all directions, and resulted in the discovery of gold and silver-bearing veins in most of the principal mountain ranges that traverse the Great Basin in a general north and south direction. First, the metal was traced southward to Esmeralda, Mono, Coso, Walker's river, Owens river, and Slate range, near the southern end of the Sierra Nevada. Eastward, the Humboldt mines, Reese river, Goose creek, Egan cañon, and Utah mines, were reached in succession, and the discoveries have been extended eastward

to the ranges of the Rocky mountains, where the prospectors met those of Colorado. Northward, in connection with the gold prospectors of Oregon, the precious metals were traced into Idaho, Montana, and British Columbia, and southward, veins have been discovered along the ranges reaching into Arizona, extending the silver region to Sonora, thus connecting the whole with the great metalliferous belt of the Mexican plateau; and with the discoveries at the extreme north, proving a continuous zone of mineral wealth through North America, from Panama to the Arctic sea.

The excitement incident to the discovery and developments upon the Comstock was intense, and claims were located by thousands in all directions. As veins were discovered at a distance new districts were organized by the miners, each with their separate records, laws, and regulations, according to which locations were made and the claims worked. Veins bearing the precious metals have since been traced in nearly every part of the State, and it is difficult to enumerate even the districts that have been organized, and in which claims of greater or less value have been located. Nevada has become the great silver region of the world, and gives promise of an enormous production of the metal for a long time in the future.

TOTAL BULLION PRODUCT OF NEVADA.

It is difficult to obtain exact statistics of the total bullion product of the State, as the shipments from Austin, Aurora, and other points, are not reported at the end of each year as at the express offices at Virginia and Gold Hill. The Reese river region has generally been considered as producing about $1,000,000 per annum, and ore and bullion are now beginning to be received from the southern districts. The following figures are believed to present a close approximation to the annual and total yield of the State up to January 1, 1868. The greater part of this amount was obtained from the Comstock lode:

1859	$50,000
1860	300,000
1861	2,300,000
1862	6,500,000
1863	12,500,000
1864	16,000,000
1865	16,800,000
1866	16,500,000
1867	18,500,000
Total	$89,450,000

The ores from many of the principal districts were exhibited in the Exposition in the collections sent from California. The principal claims upon the Comstock were so represented, and in no other way. The

eastern portion of the State, including the mines about Austin and some districts south of it, were represented by a magnificent collection of their richest ores in large masses, under the superintendence of David E. Buel, esq. These ores weighed in the aggregate several tons, and were contributed by various mine owners to an executive committee for the representation.[1] Although they reached Paris at a late date (in July,) their value and importance was such as to gain them a place in the Exposition and a recognition by the Imperial Commission in the form of a silver medal.

The following brief notices of the principal mineral districts of the State have been compiled chiefly from the writer's notes and the statistical publications mentioned below,[2–7] to which reference may be made for further details.

STOREY COUNTY.

Virginia district—Comstock lode.—The first quartz claim was located in the Virginia mining district on the 22d of February, 1858, by James Finney, generally known as "Old Virginia," from whom the city of Virginia and the croppings have taken their name. In June, 1859, two men, while washing for gold below these croppings, made an excavation to hold water upon the hill-side, and uncovered rich silver ore upon the ground now belonging to the Ophir Company. A man named Comstock was employed to purchase the claim, and thus his name has been given to the vein. As soon as the true nature of this ore was ascertained, miners flocked into the Territory, and claims were located upon the supposed course of the vein for a distance of about six miles.

The subsequent developments have shown this vein to be one of the largest and richest ever discovered, ranking with the celebrated Veta Madre of Guanajuato, and the Veta Grande of Zacatecas, Mexico. It is evidently what is termed a true fissure vein, and may be followed to a depth which will be limited by the costs of mining rather than by the absence of vein.

The elevation of this vein above the sea is about 6,000 feet, and it

---

[1] This committee was composed of the following named gentlemen: Messrs. M. J. Goodfellow, B. J. Burns, E. A. Sherman, J. R. Murphy, W. F. Leon, W. H. Clark; and they were charged with the duty of preparing a "Descriptive Report to accompany the representation of Eastern Nevada at the Paris Exposition of the world's products."

[2] La Nevada Orientale, Géographie Ressources, Climat et Etat Social; Rapport addressé au Comité local pour l'Exposition de Paris, par Myron Angel. Paris: Juillet, 1867. [Distributed at the Exposition by David E. Buel, esq.]

[3] Annual Report of the State Mineralogist of the State of Nevada for 1866, addressed to the honorable the Board of Regents of the State, by R. H. Stretch, State Mineralogist.

[4] Langley's Pacific Coast Business Directory. 8vo; San Francisco, California: 1867.

[5] Nevada Territorial Directory. 1863.

[6] Review of the Mining, Agricultural, and Commercial Interests of the Pacific States for the year 1866. Compiled by J. H. Carmany. San Francisco: H. H. Bancroft & Company. 1867; 8vo.

[7] Annual Report of the Surveyor General of the State of Nevada for the year 1865.

comes to the surface on the eastern slope of a porphyritic mountain, which has been named Mount Davidson.[1] Its course or direction is nearly north and south, and its general dip or inclination is towards the east. In width it varies from a mere seam to over 200 feet, and it is often broken up into several parallel branches which include large masses of the "country" rocks. It is remarkable for its large selvages of clay, filled with broken portions of the vein and walls, much worn and rounded by the attrition to which they have been subjected by the movement of the adjoining surfaces. Only the harder, and, in general, the more barren parts of the vein show upon the surface as "croppings." These present an irregular, brecciated appearance, have a brown color, and afforded free gold to the first miners in some places. Some of the richest bunches of ore below are found to the eastward of the heaviest croppings, and, in general, the richest ore is quite soft and granular, being broken up so as to resemble crushed sugar or salt. A mass of quartz of this kind, over 30 feet wide, in the Ophir mine, in 1861, was found to be impregnated with sulphide of silver, stephanite, and native silver and gold. A harder stratum or layer of the vein contained galena, blende, and iron pyrites.

Excavations along the line of the vein have extended by shafts to a depth of 700 to 800 feet. Several long tunnels have been run to drain the vein, the principal one being the Latrobe, commenced in 1861, and now about 3,200 feet long, which drains the mines at the north end of the lode to a depth of about 600 feet. A new tunnel, to be 20,278 feet long, and to drain the lode to a depth of 2,000 feet, is projected by Mr. A. Sutro. It is estimated that this work will occupy three or four years for its construction, and cost about $2,000,000.

The principal mining upon this vein is at Gold Hill and Virginia City, within a linear distance upon the vein of less than 8,000 feet, but explorations have been made over a length of about four miles and the existence of the vein proved. The following tabular statement gives the names of the different claims upon the line of the vein, in the order of their succession from the north southward, with the length of each in feet, the depth to which they have been worked, and other data:[2]

[1] After Donald Davidson, esq., of San Francisco, one of the first to ascend it.

[2] This table is extracted from the report of Mr. R. H. Stretch, Nevada State Mineralogist; 1866.

Table of mining claims on the Comstock lode.

Name.	Length of claim in feet.	Length explored in feet.	Per cent. of claim explored.	Depth of lowest workings.	Height of top of shaft above proposed Sutro tunnel.	Remarks.
Utah	1,000	300	30	260	....	Engine removed; not working.
Allen	925	300	32	200	....	Not working.
Sierra Nevada	1,959	400	25	650	1,796	
Union	500	5	1	80	....	Explored by tunnel; not working.
Ophir, north mine	1,200	400	33⅓			
Mexican	100	100	100	549	1,887	Explored through Ophir and Mexican shaft.
Ophir, south mine	200	200	100			
Central	150	150	100	620	1,898	
California	300	300	100	428	....	Explored by tunnel and winzes.
Central, No. 2	100	100	100	369	....	Explored by whim on White & Murphy claim, and by the Latrobe tunnel; not working.
Kinney	50	5	10	369	....	
White and Murphy	210	210	100	369	1,954	
Sides	500	200	40	500	1,955	Not working.
Best & Belcher	250	250	100	469	1,954	Not working; engine removed.
Gould & Curry	1,200	921	100	900	1,800	
Savage, old shaft	771	771	100	614	1,954	
Savage, Curtis shaft	....	......	......	448	1,787	
Hale & Norcross	400	400	100	783	1,963	
Chollar-Potosi	1,434	700	50	923	1,832	
Bullion	940	450	47	800	1,913	
Exchequer	400	......	100	540	1,819	
Alpha	278½	278½	100	680	1,800	
Apple & Bates	31½	31½	100	......	....	
Imperial, (Alta)	118	118	100	......	1,761	
Bacon	45	45	100	......	....	
Empire, north mine	55	55	100	......	1,763	
Eclipse	30	30	100	......	1,761	
French	20	20	100	......	....	
Empire, south mine	20	20	100	......	....	
Plato	10	10	100	......	....	
Bowers	20	20	100	......	....	Average depth of workings 650 feet. [1866.]
Piute	20	20	100	......	....	
Winters & Kustel	30	30	100	......	....	
Consolidated	21	21	100	......	....	
Rice Ground	13½	13½	100	......	....	
Imperial, (H. & L.)	65⅔	65⅔	100	......	....	
Challenge	50	50	100	......	1,734	
Confidence	130	130	100	......	1,725	
Burke & Hamilton	40	40	100	......	....	
Yellow Jacket	943	943	100	560	1,567	
Kentuck	93⅔	93⅔	100	460	1,543	
Crown Point	540	540	100	400	1,517	
Belcher	940	940	100	850	1,585	
Segregated Belcher	160	160	100	500	1,570	
Overman	1,200	700	60	711	1,606	
North American	2,000	......	......	300	1,620	
Baltimore American	2,000	500	25	300	....	Not working.

Most of these claims are worked by incorporated companies with capital furnished from California. The engines, machinery and supplies are freighted over the Sierra Nevada at a heavy cost, now being rapidly lessened as the Pacific railroad is pushed forward.

The above enumerated companies had excavated, before 1866, about 28 miles of tunnels and drifts, and about five and three-quarters miles of shafts, winzes, and inclines, exclusive of stopes. The dead work of one mine alone, the Gould & Curry, was in 1865 about 12,750 lineal feet of shafts and tunnels.[1]

The following table shows the number and power of the hoisting and pumping engines at work on the lode in 1866:[2]

Pumping and hoisting engines on the Comstock lode.

Company.	Hoisting engines.		Pumping engines.		Pumping and hoisting engines.	
	Number.	Horse power.	Number.	Horse power.	Number.	Horse power.
Allen					1	30
Sierra Nevada	1	60	1	200		
Ophir, (Mexican)	1	60	1	200		
Central					1	
Sides					1	30
Gould & Curry	2	60	1	150		
Savage, (old shaft)	1	60				
Savage, (new shaft)	3	60	1	300		
Hale & Norcross					1	
Potosi	1					
Chollar-Potosi	1		1			
Bullion					2	
Exchequer					1	60
Alpha					1	
Imperial					1	
Empire					2	30
Eclipse					2	30
Winters & Kustel, consolidated					2	20
Challenge					1	35
Confidence					1	25
Yellow Jacket					2	
Kentuck					1	
Belcher					2	
Segregated Belcher					2	60
Overman & Sam	2	30	2	40		
North American					1	
Baltimore American					1	

There are 76 mills, or reduction establishments, supplied by ores from the Comstock lode. These are scattered through Storey, Lyon, Ormsby, and Washoe counties. For details, reference is made to the annexed table of quartz mills in the State. The value of the mills and machinery of Storey county alone is estimated at $3,500,000.

The mills are expected to return in bullion 65 per cent. of the assay value of the pulp, which is about the average working result. There is thus a loss of 35 per cent., or about $8,000,000 annually. The cost of

[1] Report of S. H. Marlette, surveyor general.

[2] Report of State mineralogist, 1866.

working ordinary ores is from $12 to $15 per ton. A few years ago $20 and $25 per ton were paid for working. One chief element of this great expense of reduction is the cost of fuel, which is scarce in the region and commands from $15 to $20 per cord. A dwarf pine, the *piñon*, is chiefly used and is hauled a distance of 10 or 12 miles. The annual consumption of fire-wood is estimated at 144,000 cords, and is valued at nearly $2,000,000.

The lumber is brought from the Sierra Nevada, some 12 miles distant, where the supply is practically inexhaustible. The annual consumption is estimated at 35,000,000 feet board measure, worth about $1,400,000, one-half of which is for freight. Water for the mills on the lode, and for the cities of Virginia and Gold Hill, is obtained chiefly from tunnels run into the side of the mountains above, where a large and porous quartz vein, comparatively free from ores, (the Santa Rita) gives an unfailing supply. Considerable water is also obtained from the Ophir mine and other deep shafts, and from the Latrobe tunnel.

The details of the costs of mining and of working silver ores have great practical importance, and I have, therefore, devoted considerable space to their presentation, particularly as the well-arranged reports of Mr. Janin, Mr. Bonner, and other superintendents afford such rich and reliable materials. In the report of the Gould & Curry Silver Mining Company for 1865 a comparative statement of the product of the mine for the years 1862, 1863, 1864, and 1865, shows the average value of the ores that were worked, the costs of mining and of reduction at the mill belonging to the company and at custom mills. The statement is as follows:

Comparative statement of the product of the Gould & Curry mine for the years 1862, 1863, 1864, *and* 1865.

Year.	Tons produced.	1st class.	2d class.	3d class.	Average value of ores worked.	Cost of mining.	Cost of working at G. & C. mill.	Cost of working at custom mills.
1862....	8,442¼	*15¼	....	8,427	†$104 50	$12 54	....	$38 55
1863....	48,743½	*24½	4,812	43,907	80 44	12 64	$38 00	22 30
1864....	64,433	*10¼	8,821	55,602	73 48	12 00	40 00	26 00
1865....	47,217	1¼	470	46,745	45 41	10 84	12 93	20 36

* Shipped to England. † Third class ore.

It is observed that the proportion of profit increases with the richness and decreases with the poverty of the ores; thus ore yielding $75 per ton gives more than twice as much profit as $45-ore, although not twice as rich.

The costs of working mines and ores in this region are well elucidated by the following tabular statements of the quantity and cost of materials used at the Gould & Curry mine and mill during the year 1866.[1]

[1] Report State Mineralogist Nevada, p. 91.

Cost of materials for working mines and ores in Nevada.

Articles.	Quantity.	Cost.	Average price.
Wood .... cords..	11,442	$168,830 00	$14 72
Lumber .... feet...	172,857	3,725 00	*42 40
Shingles	21,500	185 00	8 60
Charcoal .... bushels.	5,848	1,659 00	28
Iron .... pounds.	12,639	1,698 00	13½
Gas pipe .... do ...	450	258 00	57⅓
Castings .... do ...	395,099	33,880 00	8½
Rivets, nuts, &c. .... do ...	853	175 00	20
Steel .... do ...	1,253	315 00	25
Copper .... do ...	178	142 00	80
Babbit metal .... do ...	262	120 00	46
Nails .... do ...	3,832	417 00	11
Zinc .... do ...	172	42 00	25
Turpentine .... gallons.	25	72 00	3 00
Belting .... pounds.	2,888	2,192 00	14 to 14 72
Packing .... do ...	494	497 00	42 40
Rope .... do ...	393	96 00	25
Hose .... do ...	136	97 00	....
Sulphate of copper .... do ...	87,353	17,588 00	20
Salt .... do ...	345,668	10,943 00	03
Lard oil .... gallons.	1,360	2,487 00	1 83
Kerosene .... do ...	985	1,615 00	1 64
Linseed .... do ...	40	99 00	2 47
Quicksilver .... flasks..	675	35,013 00	51 80
Cut bolts .... pounds.	923	214 00	23
Screens .... do ...	743	633 00	$1 to 75
Candles .... do ...	2,980	819 00	27½
Axes and handles	71	67 00	....
Picks	42	20 00	50
Shovels	239	231 00	1 38
Feed .... sacks..	487	2,087 00	....
Hay .... bales..	196	1,120 00	....
Axle grease	116	58 00	50
Copper rivets .... pounds.	280	280 00	1 00
Tallow .... do ...	10,863	1,361 00	12½
Alcohol .... gallons.	15	60 00	4 00
Brooms	189	147 00	77
Oakum .... pounds.	126	46 00	36½
Sledge handles	157	77 00	50
Lamp chimneys	531	174 00	33
Hoes	76	71 00	1 00
White and red lead	1,241	242 00	20
Blankets	43	347 00	8 00
Leather	575	246 00	42½
Stone coal	9,751	714 00	†150 00
Water	....	6,835 00	....
Sundries	....	3,833 00	....
Total	....	$301,927 00	....

* Per thousand feet. † Per ton.

The consumption and cost of these materials at the mine and mill were distributed as shown by the following valuable detailed statements from the Annual Report of the superintendent and secretary of the company. The succeeding tables show the quantity and value of ore amalgamated and the value of bullion produced, with the cost of production per ton of ore:

Months.	Officials.	Extracting ore.	Prospecting and dead work.	Accessory work.	Improvements.	Total.	Ore produced.			Ore shipped.	
							Tons.	Pounds.	Cost per ton.	Tons.	Pounds.
1865.											
December	$1,216 00	$19,833 41	$9,396 77	$10,824 67	$6,743 45	$48,014 30	5,886	1,500	$8 15	6,656	1,670
1866.											
January	1,221 00	20,919 21	10,290 19	10,210 58	3,162 08	45,797 06	6,108	....	7 50	5,979	1,690
February	1,158 00	15,032 35	10,946 94	8,344 92	3,180 75	38,662 96	4,940	500	7 82	5,188	500
March	1,035 00	15,870 69	13,696 93	8,622 14	2,644 00	41,868 76	5,141	1,000	8 14	5,355	1,550
April	1,055 00	16,108 48	13,205 65	9,378 33	2,108 77	41,856 23	5,167	....	8 10	4,816	1,940
May	1,081 00	15,284 85	11,094 56	8,927 74	2,037 47	38,425 62	4,662	....	8 24	5,059	1,235
June	1,080 00	13,412 17	10,095 61	9,264 90	2,486 87	36,339 55	4,126	500	8 80	3,831	1,580
July	1,101 00	11,779 78	12,384 43	6,725 66	4,054 48	36,045 35	3,940	....	9 15	4,064	....
August	1,101 00	15,533 69	12,244 01	9,914 34	1,768 49	40,561 53	5,348	....	7 58	5,019	....
September	1,060 00	15,582 15	12,676 88	9,315 36	2,462 07	41,096 46	5,951	....	6 90	5,408	....
October	1,086 00	18,217 02	7,525 93	11,616 11	3,884 93	42,329 99	5,703	929	7 42	5,783	350
November	1,060 00	16,254 92	8,139 19	10,701 71	3,968 89	40,124 71	5,450	1,500	7 36	4,761	1,414
Total	$13,254 00	$193,822 72	$131,697 09	$113,846 46	$38,502 25	$491,122 52	62,424	1,929	....	61,924	1,929
Average per ton	$0 21	$3 10	$2 11	$1 82	$0 62	$7 86	....	....	....	....	....

Detailed statement of cost at the Gould & C

Description.	1865.	1866.			
	December.	January.	February.	March.	Apr
Officers, general labor, watchmen, teamsters, &c.	$2, 446 88	$2, 414 75	$2, 399 88	$2, 212 62	$2, 2
DRIVING POWER.					
Labor	$1, 834 25	$1, 872 25	$1, 677 25	$1, 813 37	$1, 6
Wood	14, 219 00	13, 620 00	11, 579 00	15, 619 00	13, 3
Sundries	494 00	442 00	291 00	480 00	3
Total	$16, 547 25	$15, 934 25	$13 547 25	$17, 912 37	$15, 5
PREPARING ORE FOR BATTERIES.					
Labor	$1, 648 12	$1, 552 25	$1, 466 25	$1, 677 74	$1, 2
Sundries	....	....	....	521 00	2
Total	$1, 648 12	$1, 552 25	$1, 466 25	$2 198 74	$1, 5
BATTERIES.					
Labor	$2, 570 00	$2, 470 00	$2, 344 50	$2, 502 00	$2, 2
Castings	1, 073 00	811 00	536 00	969 00	7
Sundries	331 00	227 00	339 00	302 00	3
Total	$3, 974 00	$3, 508 00	$3, 219 50	$3, 773 00	$3, 4
AMALGAMATING.					
Labor	$2, 654 88	$2, 558 75	$2, 526 25	$2, 687 25	$2, 47
Retort wood	200 00	219 00	160 00	320 00	2
Castings	2, 253 00	1, 933 00	1, 106 00	2, 945 00	2, 3
Salt	1, 043 00	1, 131 00	1, 121 00	1, 181 00	6
Sulphate of copper	1, 948 00	2, 138 00	2, 572 00	2, 863 00	1, 2
Quicksilver	2, 850 00	3, 000 00	2, 964 00	2, 754 00	2, 6
Sundries	398 00	362 00	349 00	376 00	3
Total	$11, 346 88	$11, 341 75	$10, 798 25	$13, 126 25	$9, 91
REPAIRS.					
Labor	$2, 539 12	$2, 804 75	$2, 751 75	$2, 677 61	$2, 8
Sundries	2, 901 00	2, 295 00	1, 912 00	3, 173 00	2, 2
Total	$5, 440 12	$5, 099 75	$4, 663 75	$5, 850 61	$5, 1
TOTAL COST.					
Labor	$13, 693 25	$13, 702 75	$13, 165 88	$13, 570 59	$12, 7
Material	27, 710 00	26, 178 00	22, 929 00	31, 503 00	25, 6
Hauling ore from mine	3, 010 29	2, 744 10	3, 093 07	3, 299 58	3, 1
Grand total	$44, 413 54	$42, 624 85	$39, 187 95	$48, 373 17	$40, 9

[1] From the Annual Report of the Gould & Curry Silver Mining Com

mill for the year ending November 30, 1866.[1]

1866.							
May.	June.	July.	August.	September.	October.	November.	Total.
$2,559 25	$2,778 50	$2,495 25	$2,575 50	$2,352 00	$2,315 25	$1,969 75	$28,841 13
$1,714 25	$1,688 25	$1,645 12	$1,703 00	$1,648 75	$1,707 00	$1,616 50	$20,574 49
17,630 00	12,481 00	11,959 00	11,774 00	11,370 00	13,268 00	14,010 00	160,858 00
388 00	517 00	485 00	376 00	394 00	341 00	321 00	5,052 00
$19,732 25	$14,686 25	$14,089 12	$13,853 00	$13,412 75	$15,316 00	$15,947 50	$186,484 49
$1,279 62	$1,274 25	$1,328 00	$1,278 75	$1,378 00	$1,256 00	$1,282 25	$16,710 48
36 00	67 00	70 00	111 00	66 00	69 00	139 00	1,350 00
$1,315 62	$1,341 25	$1,398 00	$1,389 75	$1,444 00	$1,325 00	$1,421 25	$18,060 48
$2,138 00	$1,933 12	$2,117 25	$2,148 37	$2,106 00	$2,037 00	$2,069 87	$26,677 99
370 00	464 00	839 00	563 00	836 00	463 00	723 00	8,434 00
407 00	316 00	424 00	326 00	373 00	381 00	379 00	4,201 00
$2,915 00	$2,713 12	$3,380 25	$3,037 37	$3,315 00	$2,881 00	$3,171 87	$39,312 99
$2,517 00	$2,238 75	$2,664 75	$2,794 50	$2,730 50	$2,493 37	$2,714 00	$31,057 00
232 00	264 00	....	192 00	....	62 00	....	1,881 00
1,468 00	910 00	3,288 00	1,600 00	2,482 00	1,388 00	2,296 00	24,001 00
701 00	517 00	557 00	1,079 00	1,168 00	710 00	1,118 00	10,943 00
1,518 00	1,159 00	966 00	995 00	916 00	527 00	769 00	17,588 00
3,605 00	2,777 00	2,983 00	3,629 00	3,056 00	2,082 00	2,664 00	35,013 00
357 00	321 00	478 00	310 00	317 00	365 00	391 00	4,414 00
$10,398 00	$8,186 75	$10,936 75	$10,599 50	$10,669 50	$7,627 37	$9,952 00	$124,897 00
$2,807 50	$2,779 62	$2,604 37	$2,985 87	$2,713 37	$3,068 62	$3,427 37	$34,003 70
2,825 00	1,896 00	1,895 00	2,359 00	1,756 00	2,259 00	2,459 00	28,016 00
$5,632 50	$4,675 62	$4,499 37	$5,344 87	$4,469 37	$5,327 62	$5,886 37	$62,019 70
$13,015 62	$12,692 49	$12,854 74	$13,485 99	$12,928 62	$12,877 24	$13,079 74	$157,864 79
29,537 00	21,689 00	23,944 00	23,314 00	22,734 00	21,915 00	25,269 00	301,751 00
3,365 56	2,691 32	3,233 48	3,169 73	3,309 16	2,522 31	2,793 15	36,389 13
$45,918 18	$37,072 81	$40,032 22	$39,969 72	$38,971 78	$37,314 55	$41,141 89	$496,004 92

Louis Janin, jr., superintendent; David Bowie, secretary.

Quantity and value of ore amalgamated at the Gould & Curry mill, and value of bullion produced, in one year ending Nov. 30, 186[illegible]

Month.	Ores. Delivered to mill.		Ores. Amalgamated.	Assay per ton.	Value of ores.	[illegible]duced.* [illegible]	[illegible]r.	Total.
	Tons.	*Pounds.*	*Tons.*					
1865—December	3,344	1,535	3,138	$4[illegible]	[illegible]	$27,303 19	$63,113 39	$90,416 58
1866—January	3,049	15	2,744	[illegible]	[illegible]	23,186 22	61,005 13	84,191 35
February	3,436	1,465	2,960	[illegible]	[illegible]	30,223 74	70,020 46	100,244 20
March	3,666	395	3,055	[illegible]	[illegible]	39,667 22	98,315 48	137,982 70
April	3,508	405	2,908	[illegible]	[illegible]17 82	33,251 75	82,799 53	116,051 28
May	3,739	1,030	3,085	[illegible]	[illegible]76 40	43,721 02	87,141 72	130,862 74
June	2,990	715	2,601	[illegible]	[illegible]80 96	29,143 82	63,007 28	92,151 10
July	3,592	1,500	3,181	[illegible]	[illegible]39 67	26,148 18	58,781 81	84,929 99
August	3,521	1,850	3,135	[illegible]	[illegible] 55	31,637 56	70,869 57	102,507 13
September	3,676	1,695	3,232	[illegible]	[illegible]	27,510 41	63,931 12	91,441 53
October	2,802	1,135	2,902	[illegible]	[illegible]	17,182 91	39,377 43	56,560 34
November	3,103	1,015	3,660	[illegible]	[illegible]	34,827 90	66,914 93	101,742 83
Total	40,432	755	36,001	....	$1,582,247 43	$363,803 92	$825,277 85	$1,189,081 77

Cost of working per ton of ore.

	Labor.	Silver.	Castings.	Sulphate copper.	Salt.	Quicksilver.	Sundries.	Total.
General foreman, watchmen, laborers, &c.	$0 71.33	....	....	....	....	....	....	$0 71.33
Driving power	50.88	$3 97.84	....	....	....	....	$0 12.49	4 61.21
Preparing ore for batteries	41.32	....	....	....	....	....	3.33	44.65
Batteries	65.98	....	$0 20.85	....	....	....	10.39	97.22
Amalgamating	76.81	4.65	59.36	$0 43.50	$0 27.06	$0 86.59	10.96	3 08.93
Repairs	84.10	....	....	....	....	....	69.31	1 53.41
Hauling ore to mill	....	....	....	....	....	....	90.00	90.00
Total	$3 90.42	$4 02.49	$0 80.21	$0 43.50	$0 27.06	$0 86.59	$1 96.48	$12 26.75

The average cost of extraction per ton of ore, including prospecting and dead work and improvements, is thus shown to be $7 86, and the average cost of working the ore per ton $12 26.

The following shows the average contents, yield, and loss per ton:

Average assay, per ton	$43 95
Average yield, per ton	33 02
Loss, per ton	10 93
Cost per ton for amount of ore crushed	12 26.75
Cost per ton for amount of ore amalgamated	13 77.78

The difference between amount of ore crushed and amalgamated shows loss in slimes and the moisture contained in the ore:

Estimated amount of slimes in reservoirs.................. 3,500 tons.
Estimated profit in working slimes........ $12 50 per ton = $43,750.

The following table exhibits the total ore and bullion product of the Gould & Curry mine, the average yield per ton, and the dividends paid, from the date of the incorporation of the company (June 27, 1860) to November 30, 1866:[1]

Product of the Gould & Curry mine to December, 1866.

Date.	Ore worked, &c.	Bullion, &c.	Average yield per ton.	Dividends paid.
	Tons.			
From July 1, 1860, to December 13, 1860	140¼	$22,004 82	$156 62	....
From December 14, 1860, to December 13, 1861	300	44,221 41	147 40	....
From December 14, 1861, to November 30, 1862	8,442¼	842,538 80	99 80	....
From December 1, 1862, to November 30, 1863	48,745	3,902,712 64	80 07	$1,468,800
From December 1, 1863, to November 30, 1864	66,477¾	4,798,124 90	72 18	1,440,000
From December 1, 1864, to November 30, 1865	46,022¾	2,026,172 57	44 02	618,000
From December 1, 1865, to November 30, 1866	60,417¼	1,690,952 25	28 00	252,000
Total	....	$13,326,727 39		
From tailings	....	300,143 76		
Worked ... tons	230,546	$13,626,871 15	$59 02	$3,778,800
On hand December 1, 1866 ... do	4,249½			
Total product	234,795½			

The average yield of the ores worked from the Comstock lode is further shown by the following data from the principal mines:

Mine.	Tons reduced.	Average yield.
Hale & Norcross	22,626	$46 65
Savage	29,535	42 38
Crown Point	33,377	38 15
Gould & Curry	(²) 230,546	59 02
Empire	19,750	24 69
Ophir	11,163	42 50

[1] Carmany's Review, page 56. [2] Average from July 1, 1860, to November 30, 1866.

Assessments of Washoe mining companies.

Company.	During the year 1867.												
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Alpha											$12,000		$12,000
Bacon													
Baltimore American	$5,200												5,200
Belcher	15,600		$12,480			$15,600			$15,600			$15,600	74,880
Bullion		$25,000			$25,000	25,000	$37,500			$25,000			137,500
Chollar-Potosi												42,000	42,000
Central													
Confidence		39,000		$15,600		15,600							70,200
Crown Point										60,000			60,000
California						30,600							30,600
Daney	4,000			4,000		24,000			12,000				44,000
Exchequer												16,000	16,000
Gould & Curry									120,000				120,000
Hale & Norcross												60,000	60,000
Justice and Independent							15,000		30,000				45,000
Lady Bryan													
Ophir	84,000						50,400		50,400				184,800
Overman			32,000										32,000
Segregated Belcher								$6,400					6,400
Sides	1,500					12,500							14,000
Sierra Nevada		12,000		12,000		30,000			30,000			12,000	96,000
White & Murphy							5,670						5,670
Yellow Jacket										120,000	120,000		240,000
Total	$110,300	$76,000	$44,480	$31,600	$25,000	$153,300	$108,570	$6,400	$258,000	$205,000	$132,000	$145 600	$1,296,250

Assessments of Washoe mining companies—Continued.

Company.	During the year 1866.												
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Alpha		$36,000		$60,000									$96,000
Bacon								$9,000			$9,000		18,000
Baltimore American			$5,200		$7,800								13,000
Belcher			62,400				$46,800			$34,320			143,520
Bullion	$25,000	25,000	25,000	25,000			25,000		25,000		25,000		175,000
Chollar-Potosi													
Central							9,000						9,000
Confidence				39,000									39,000
Crown Point													
California													
Daney		4,000		4,000		$6,000		6,000		6,000			26,000
Exchequer			16,000			16,000							32,000
Gould & Curry													
Hale & Norcross													
Justice and Independent													
Lady Bryan	5,000		5,000		5,000								15,000
Ophir										100,800		84,000	184,800
Overman	32,000	48,000			32,000			48,000		15,000		32,000	208,000
Segregated Belcher													
Sides													
Sierra Nevada		6,000		12,000		6,000		12,000		7,500		12,000	55,500
White & Murphy													
Yellow Jacket		180,000											180,000
Total	$62,000	$299,000	$113 600	$140,000	$44,800	$28,000	$80,800	$75,000	$25,000	$164,620	$34,000	$128,000	$1,194,820

During 1867 the companies mining on the Comstock lode declared dividends to the amount of four millions of dollars. The dividends for 1866 were only $1,754,400, showing an increase of $2,245,600. In 1867 the assessments levied by twenty companies reached $1,296,250, against $1,194,820 levied by fourteen companies in 1866.

Dividends of the leading claims on the Comstock lode.

DURING THE YEAR 1867.

Company.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.	Per share.
Savage	$80,000	$80,000	$80,000	$80,000	$120,000	$160,000	$240,000	$200,000	$200,000	$120,000	$120,000	$120,000	$1,600,000	$100 00
Hale & Norcross	40,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000				440,000	550 00
Imperial	32,000	48,000	60,000	60,000	60,000	40,000	40,000	40,000					380,000	95 00
Yellow Jacket	60,000				60,000	90,000	90,000						300,000	250 00
Chollar-Potosi					70,000	70,000	70,000	70,000	70,000	70,000			420,000	150 00
Kentuck	10,000	20,000	30,000	40,000	40,000	60,000	80,000	80,000	50,000	50,000	15,000	30,000	505,000	252 50
Crown Point	60,000	60,000	48,000	48,000	48,000								264,000	110 00
Gold Hill Quartz M. & M. Company	*			5,000	5,000	5,000	7,500	7,500				3,750	33,750	67 50
Empire Mill & M. Co.	12,000	18,000	12,000		7,200								49,200	41 00
Gould & Curry														
Total	$294,000	$276,000	$280,000	$283,000	$460,200	$475,000	$577,500	$447,500	$370,000	$240,000	$135,000	$153,750	$3,991,950	

DURING THE YEAR 1866.

Company.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.	Per share.
Savage							$40,000	$40,000	$40,000	$60,000	$60,000	$80,000	$320,000	$20 00
Hale & Norcross				$20,000	$20,000	$20,000	30,000	30,000	30,000	40,000	40,000	120,000	350,000	437 50
Imperial					40,000		24,000	24,000	24,000		32,000	32,000	176,000	44 00
Yellow Jacket							60,000	60,000	60,000	60,000	60,000	90,000	390,000	325 00
Chollar-Potosi														
Kentuck														
Crown Point			$30,000	48,000	48,000	48,000					30,000	30,000	234,000	97 50
Gold Hill Quartz M. & M. Company														
Empire Mill & M. Co.										7,200	7,200	18,000	32,400	27 00
Gould & Curry	$60,000			96,000		96,000							252,000	52 50
Total	$60,000		$30,000	$164,000	$108,000	$164,000	$154,000	$154,000	$154,000	$167 200	$229,200	$370,000	$1,754,400	

The bullion product of some of the principal mines upon the Comstock lode at Virginia and Gold Hill, the dividends paid and the assessments levied for the years 1866 and 1867, are shown by the foregoing tables.[1]

These tables do not include all of the dividend-paying mines, for many of the valuable claims at Gold Hill are private property, and no reports of their production are made.

The Savage mine for the fiscal year ending July 10, 1866, produced ore to the following amounts and values, at a cost of extraction per ton of $18 06:

	Tons.	Pounds.
First-class ore	435	1,290
Second-class ore	26,338	1,650
Third-class ore	3,878	750
Total	30,652	1,690

The product of the ores reduced was:

	Value.		Per ton
First-class	$93,220 04		$224 08
Second-class	1,096,449 23		42 04
Third-class	62,084 54		20 43
Total	$1,251,753 81	Average.	$42 38

The following tables show the monthly shipments of bullion from the Comstock lode for 1865 and 1866 from the two express offices of Wells, Fargo & Co., at Virginia City and at Gold Hill:

Bullion shipped from Virginia City and Gold Hill, Nevada, for 1865 *and* 1866, *by Wells, Fargo & Co.*

Months.	1865.			1866.		
	Gold Hill.	Virginia City.	Total.	Gold Hill.	Virginia City.	Total.
January	$253,602 89	$940,152 13	$1,193,755 02	$432,044 28	$520,177 20	$952,221 48
February	229,856 24	1,033,855 89	1,263,712 13	475,491 63	492,322 91	968,814 54
March	235,485 68	1,154,749 76	1,390,335 44	490,123 89	705,210 33	1,195,334 22
April	150,102 45	1,191,172 00	1,341,274 45	413,177 17	646,987 51	1,060,164 68
May	197,802 30	1,012,435 59	1,210,237 89	562,074 83	648,776 71	1,210,851 54
June	246,725 62	694,256 11	940,981 73	673,111 40	562,938 70	1,236,050 10
July	260,001 59	511,127 57	771,129 16	673,385 93	595,503 77	1,268,889 70
August	314,808 93	550,730 78	865,539 71	672,690 14	779,276 59	1,451,966 73
September	399,613 99	492,203 79	891,817 78	700,940 33	643,963 97	1,344,904 30
October	496,165 00	547,365 58	1,043,530 58	726,464 08	686,517 23	1,412,981 31
November	408,307 90	539,217 76	947,525 66	613,779 62	739,512 30	1,353,291 92
December	354,425 00	619,455 28	973,880 28	666,984 70	786,438 96	1,453,423 66
Total	$3,546,897 59	$9,286,822 24	$12,833,719 83	$7,100,268 00	$7,807,626 18	$14,907,894 18

It should be noted that these totals do not present the entire yield of the Comstock lode for the two years, for the bullion from some of the ores is shipped from Carson City, and other points. The bullion from Carson City, in 1866, amounted to $341,366 80.

[1] Carmany's Review, 1867.

Bullion product of the leading claims on the Comstock

DURING THE YEAR 1866.

Company.	January.	February.	March.	April.	May.	June.
Hale & Norcross..	....	$51, 546 03	$64, 059 33	$62, 027 18	$55, 942 46	$104, 247 33
Savage...........	$140, 000 00	150, 000 00	110, 000 00	66, 553 70	115, 000 00	130, 000 00
Crown Point......	52, 327 14	155, 461 63	148, 552 35	115, 102 11	110, 514 82	109, 601 05
Yellow Jacket....	111, 794 13	85, 000 00	96, 519 65	84, 827 28	130, 366 24	292, 274 00
Gould & Curry...	133, 153 95	152, 964 76	174, 096 46	142, 472 28	150, 804 21	146, 640 49
Chollar-Potosi....	43, 200 00	59, 745 00	85, 950 00	87, 338 00	90, 359 00	74, 862 00
Empire M. & M. Company	38, 191 82	36, 000 00	27, 697 00	29, 542 49	34, 363 04	34, 482 75
Imperial.........	81, 891 21	74, 823 60	48, 223 90	91, 533 61	67, 755 89	62, 240 90
Confidence.......	19, 474 12	10, 141 19	12, 474 01	17, 624 09	15, 869 42	20, 869 47
Ophir, (aggregate).	51, 523 04	27, 478 51	49, 604 45	84, 340 81	81, 593 57	25, 665 89
Kentuck.........	....	....	....	....	....	....
Gold Hill Q. M. & M. Company....	....	....	....	....	....	....
Overman, (aggregate)......	....	....	....	....	....	....
Total........	$671, 555 41	$803, 160 72	$817, 177 15	$781, 361 55	$852, 568 65	$1, 000, 883 [illegible]

DURING THE YEAR 1867.

Company.	January.	February.	March.	April.	May.	June.
Hale & Norcross..	$102, 571 72	$117, 639 44	$79, 144 02	$76, 462 58	$150, 826 68	$117, 728 21
Savage...........	250, 000 00	270, 000 00	150, 000 00	337, 000 00	408, 000 00	370, 493 96
Crown Point.....	140, 000 00	129, 850 00	64, 541 58	63, 971 00	82, 000 00	77, 550 00
Yellow Jacket[2]...	156, 200 37	117, 488 97	108, 913 85	222, 075 44	278, 684 63	195, 913 65
Gould & Curry...	66, 423 00	45, 165 41	52, 878 47	63, 130 19	74, 862 68	44, 446 46
Chollar-Potosi....	80, 000 00	100, 000 00	86, 000 00	245, 094 00	334, 289 17	345, 000 00
Empire M. & M. Company	38, 153 00	26, 787 00	23, 081 00	22, 884 66	21, 933 00	21, 500 00
Imperial.........	115, 948 67	116, 200 00	90, 431 96	95, 162 91	94, 000 00	107, 000 00
Confidence.......	24, 006 10	11, 411 86	8, 052 71	18, 202 78	12, 000 00	14, 000 00
Ophir, (aggregate)	....	....	....	....	....	....
Kentuck.........	43, 674 71	70, 095 42	58, 572 85	108, 953 53	132, 333 88	130, 255 31
Gold Hill Q. M. & M. Company....	5, 400 00	9, 600 00	7, 300 00	10, 000 00	10, 866 62	12, 500 00
Overman, (aggregate).........	....	....	....	....	....	....
Total........	$1, 022, 377 57	$1, 014, 238 10	$728, 916 44	$1, 262, 937 09	$1, 599, 796 66	$1, 436, 387 81

[1] From Carmany's Annual Mining Review.

[2] The bullion product of the Yellow Jacket claim has been estimated for the last six months of 1867, as

lode during the year 1867, *as compared with* 1866.[1]

DURING THE YEAR 1866.

July.	August.	September.	October.	November.	December.	Total.
$125,073 00	$119,447 38	$153,666 63	$152,363 74	$167,034 89	$131,135 41	$1,186,543 38
140,000 00	162,478 00	145,000 00	210,000 00	231,000 00	214,847 39	1,814,879 09
36,557 00	80,451 10	116,573 76	111,150 17	91,326 00	184,854 00	1,312,471 13
281,706 00	379,699 92	292,566 78	180,288 67	202,090 27	160,000 00	2,297,132 94
125,000 00	134,395 23	117,821 35	114,321 67	124,683 61	108,427 00	1,624,781 01
71,641 00	65,682 00	50,367 00	58,962 00	60,645 00	100,000 00	848,751 00
28,440 76	31,520 25	41,813 15	42,000 00	45,000 00	33,240 12	422,291 38
65,408 16	75,840 52	78,459 87	99,476 87	83,687 17	81,045 67	910,387 37
46,196 74	29,696 58	37,059 56	41,563 72	27,975 69	25,987 12	304,931 71
19,582 60	27,684 56	20,683 22	22,586 24	6,729 19	....	417,472 08
....	....	....	....	....	....	571,506 79
....	....	....	....	....	....	....
....	....	....	....	....	....	27,953 00
$939,605 26	$1,106,895 54	$1,054,011 32	$1,032,713 08	$1,040,171 82	$1,039,536 71	$11,738,100 88

DURING THE YEAR 1867.

July.	August.	September.	October.	November.	December.	Total.
$133,906 17	$124,664 69	$71,950 24	$49,980 22	$57,655 81	$14,767 65	$1,097,297 45
375,000 00	359,644 37	360,295 29	352,066 00	310,681 00	193,919 50	3,737,100 12
120,043 00	54,291 85	49,000 00	42,071 23	50,299 30	47,100 00	920,717 96
160,000 00	150,000 00	130,000 00	100,000 00	60,000 00	50,000 00	1,729,276 91
....	30,043 11	75,842 74	65,474 86	90,235 69	6,117 90	614,620 51
311,681 17	350,000 00	252,000 00	253,866 89	164,976 67	145,977 46	2,668,885 36
26,312 32	22,333 80	18,689 40	20,571 43	18,757 48	17,604 08	278,607 17
99,627 54	89,280 00	97,980 00	68,897 94	63,395 48	68,571 00	1,106,495 50
16,527 52	12,304 17	11,310 11	13,547 71	686 50	....	142,049 46
....	....	....	....	....	....	4,108 00
125,767 31	104,215 35	101,000 00	102,326 65	65,250 16	98,296 57	1,140,741 94
10,250 57	9,771 52	3,259 04	10,995 79	12,182 26	4,273 02	106,399 42
....	....	....	....	....	....	192,318 17
$1,379,115 60	$1,306,548 86	$1,171,326 82	$1,079,798 72	$894,120 35	$646,627 78	$13,738,617 97

the figures could not be obtained from the office of the company at Virginia.

TOTAL BULLION PRODUCT OF THE COMSTOCK LODE.

The statistics of the total yield of the Comstock lode, since wo commenced upon it, differ somewhat as presented by different p The Surveyor General of Nevada, in his report for the year 1865, est the total yield up to 1866 at $45,000,000. Commissioner Brown mated it to be $66,000,000 up to January, 1867. This last sum is ob by subtracting five or six per cent. from the total yield of the supposed to have been $70,725,000 up to the end of 1866.

In the year 1859 nothing was extracted but some rich ores fr surface, and a few thousand dollars' worth of gold washed from th crops and the ravine below them. Some of the ores were wor arrastras at Gold Hill. The next year, 1860, three or four smal were started, and the product was about $100,000, to which $200,000 may be added for rich ores shipped to California, New and Europe.

It is believed that the following figures, derived from the source and the writer's notes previous to 1865, fairly represent the prod of the Comstock lode up to the 1st of January, 1868:

1859, ore and bullion	....	$[illegible]
1860	"	3[illegible]
1861	"	2,0[illegible]
1862	"	6,0[illegible]
1863	"	12,4[illegible]
1864	"	16,0[illegible]
1865	"	13,0[illegible]
1866	"	15,2[illegible]
1867	"	16,5[illegible]
Total to January 1, 1868	....	$81,5[illegible]

This bullion product consists of a mixture of gold and silver, a ratio in value of the two metals is, gold 34.8, silver 65.3, as shown b following table compiled from assays made at the Silver State Red Works by Louis Janin, jr., during 1863 and 1864.[1]

[1] From Report of State Mineralogist, p. 127.

Table showing the relative value of gold and silver in ores from the Comstock lode.

Name of mine.	No. of tons.		Percentage in value.	
			Gold.	Silver
	Tons.	*Lbs.*		
Mexican	267	200	42.49	57.51
	225	1,600	41.17	58.83
	398	300	50.68	49.32
	395	720	52.00	48.00
	1,147	200	51.25	48.75
	26	8	49.26	50.74
Savage	175	790	22.85	77.15
	222	450	26.48	73.52
	307	800	24.00	76.00
	373	1,200	24 68	75.32
	168		33.94	66.06
	89		32.29	67.71
Potosi	133		25.84	74.16
Uncle Sam	297	1,680	35.64	64.51
	225	620	37.94	62.06
	91	1,000	21.20	78.80
	82	1,000	34.16	65.84
	129	1,160	31.70	68.30
Gould & Curry	440		24.63	75.37

Adopting this ratio the total bullion product of the Comstock lode may be divided as follows:

Gold, value	$28,300,000
Silver, value	53,200,000
Total	$81,500,000

LANDER COUNTY.

This county occupies the northeastern corner of the State, but the principal mining districts are along the western and southern boundaries. The following extract[1] gives the particulars of the discovery of silver in this section of the State: "Early in the month of May, 1862, William M. Talcott, an attaché of the stage station at Jacob's Springs, while hauling wood from the hill-side, now within the limits of the city of Austin, discovered a vein of metal-bearing quartz, and carried a small quantity with him to the station. The rock proved to contain silver; the lode was located as a mining claim, and named the 'Pony,' as the discoverer had formerly been a rider of the Pony Express. On the 10th day of May, 1862, a mining district was formed, including an area of 75 miles east and west, and 20 north and south, and named the Reese River Mining District." From this point the discoveries extended north and south; other districts were formed, and the Reese River district was repeatedly subdivided. The following table gives the names of the

[1] Harrington's Austin Directory.

majority of the districts in that section of the State, which, tog
with Nye county, is known as eastern Nevada. The discovery of s
was made upon the western slope of the Toiyabe range, which
nearly north and south, and extends into Nye county.

List of districts in Lander county.

On western slope of the Toiyabe range:

1. Washington, 25 miles south of Austin.
2. Big Creek, 12 miles south of Austin.
3. Reese River, containing the towns of Austin and Clifton.
4. Amador, 6 miles north of Austin.
5. Mount Hope, 12 miles north of Austin.
6. Cumberland, 15 miles north of Austin.
7. Columbus, 20 miles north of Austin.
8. Mount Vernon, 30 miles north of Austin.

On eastern slope of the Toiyabe range:

9. Bunker Hill, 25 miles south of Austin.
10. Summit, 20 miles south of Austin.
11. Santa Fé, 20 miles south of Austin.
12. Smoky Valley, 12 miles south of Austin.
13. Simpson's Park, east of Austin.
14. Indian district, 15 miles north of Austin.
15. Callaghan ranch, 16 miles north of Austin.
16. Wall street, 25 miles north of Austin.
17. Cortez, 65 miles north of Austin.
18. Yreka, 75 miles north of Austin.

On the second range east of Toiyabe:

19. Eureka, 60 miles east of Austin.
20. Newark, 70 miles east of Austin.
21. Diamond, 80 miles east of Austin.
22. White Pine, 90 miles east of Austin.
23. Cascade, 90 miles east of Austin.

In the Ruby valley region:

24. Ruby, 125 miles east of Austin.
25. Wolf mountain, 120 miles east of Austin.

In the region of Egan cañon:

26. Gold cañon, 160 miles east of Austin.
27. Hercules, 150 miles east of Austin.
28. Antelope, 200 miles east of Austin.
29. Kinsley, 200 miles east of Austin.

It is well to observe that the veins in these districts, with the excep
of Reese River district, are comparatively undeveloped. Some of
districts have been prospected and nearly abandoned, the veins
proving equal to the sanguine expectations of the locators, or not be
rich enough to be profitably worked. The locations in some of th

counted by hundreds and thousands, and generally but a
itage of them afford encouraging prospects to the intelligent

s in the vicinity of Austin, in the Reese River district, have
t known, are most explored, and are more generally produc-
cations in some of the neighboring districts.

r district.—In this district there are more than 6,000 locations
claims of from 500 to 2,000 feet each. Only a few of these
nt mined to any great extent.

formation is chiefly a compact granite. This is traversed by
nd very rich veins of silver ore in quartz. These veins vary
ickness of a card to one and two feet, and may be said to
to 15 inches. They are generally parallel, are often within a
each other, and dip at various angles. They are remarkable
hness in silver and for the absence of gold. The following
cipal silver minerals which have been found to compose the
e ore in most of the veins: dark and light red silver ore,
is gray copper, antimonial sulphuret of silver, polybasite, and
r portions of the veins, where the ore has decomposed, chlor-
r and native silver are abundant. It is probable that iodide
e of silver also occur in the surface ores.

ving statement of the product of the veins in Lander county
three months of 1866[1] shows the remarkable richness of
and the extent to which they were worked.

luct of mines in Lander county for last quarter of 1866.

Name of mine.	No. of tons.		Average per ton.
	Tons.	*Lbs.*	
	143	1,909	$91 18
	1	250	168 75
	4	920	336 57
	12	973	116 57
	4	438	405 10
	1		111 53
	4	779	187 65
	7	619	99 22
	1	667	66 25
	4	416	177 28
	13	1,900	255 60
	7	1,359	54 00
	7	1,520	30 33
	3	1,453	71 12
	27		217 94
	22	1,695	220 42
	1	100	251 18
	1	1,350	27 85
	1		116 80
	2	350	194 66
	1		197 27
	1	728	100 61

assessor's books; quoted in the Report of State Mineralo ist, pp. 99, 100.

Product of mines in Lander county for last quarter of **1866—Continu**

Name of mine.	No. of tons.		Av per
	Tons.	*Lbs.*	
Lodi	7	1,019	[illegible]
Livermore	3	500	
Mount Tenabo (Cortez)	...		...
Morgan & Muncey	4	626	
Magnolia	6	1,671	[illegible]
Metacom	26		[illegible]
Manhattan Company	69	262	
May & Davis	2	430	[illegible]
North river	13	1,924	
Owen & Perkins	3	1,700	
Providential	64	844	
Pinney, Rev	6	600	
Patten	2	824	[illegible]
Remington	6	1,500	
Savage, consolidated	451		1
Silver Queen	14	1,913	
Surprise	1		1
Semanthe	2	150	3
Tinoke	79	1,138	1
Taylor & Passmore (Cortez)	5	982	1
Tunnehill (Eureka)	3	1,318	1
Victoria	4	1,176	[illegible]
Washington	12	67	4
Whitlatch Union	18	546	1
Zimmerman	5	1,278	[illegible]

According to the assessor's returns there are in Lander county, a mainly in Reese River district, fully 75 mines, which have produ bullion during the year, (1866.)

The ores of this district in the vicinity of Austin were freely re sented at the Exposition by large masses of exceedingly rich ore, in wh ruby silver was conspicuous.

Cortez district.—The principal veins of this district were discove in 1863, and are remarkable for their enormous size. The largest is "Nevada Giant," on Mount Tenabo, about 3,000 feet above its base. can be followed for 18,600 feet, and some 20 locations, varying from 10 4,000 feet each, have been made upon it. The Gill, Taylor & Passmo and St. Louis locations have been worked, and the "Cortez Giant," n the centre of the vein, has yielded a considerable amount of bullion. T following is a list of the claims: Commencing at its greatest altit is the Chieftain: Genessee Company, 1,400 feet; Murphy Compa 800; Gill Company, 800; Taylor and Passmore, 800; De Witt Compa 150; St. Louis Company, 2,000; Meacham and Brothers, 400; Niag Company, 400; Savage Company, 400; Nebraska Company, 1,200; Cor Giant: Mount Tenabo Company, 4,000; Elmore Company, 200; Rus Company, 600; Continental Company, 1,000; Argentine Company, 1,0 Empire Company, 800; Coun and Brothers, 400; Travesse Compa

400; and the Anna Burr Company, 2,000 feet. The vein on the last-mentioned claim is somewhat broken, and at the end of the claim the vein disappears, and is lost altogether.

Washington district.—The principal ores in this district are argentiferous galena. The St. Helena mine has been opened to a considerable depth, but in general the district is at present deserted, owing to the difficulty and expense of working the ores. The veins are represented to be large and regular.

Eureka district.—Organized in 1864. The ores of this district are reported to be argentiferous galena, and to have yielded from 150 to 450 dollars a ton in Austin, where some small lots were taken to be worked.

Kinsley district.—"The Kinsley district is distinguished for its massive ledges of copper ore. It is in the Antelope range of mountains, near the eastern border of the State, 45 miles northeast of Egan, and 210 miles from Austin. The ledges of ore are of immense size, and many hundreds of tons of ore are represented as being upon the surface, which are proven by numerous assays to contain from 35 to 50 per centum of copper, and from $60 to upwards of $100 per ton in silver. The district is but little known; its great distance from the centres of population and a market rendering copper mines valueless for present purposes. The great Pacific railroad, now in course of rapid construction, is expected to pass through or near the district."[1]

Gold Cañon district.—"Gold Cañon district is one of the furthest east of Nevada, being 165 miles from Austin. It is better known as Egan Cañon. It was organized in 1863, and native gold showing plainly in the quartz of some of the veins first discovered, gave it the name of Gold Cañon. It lies upon the great trans-continental highway, where the overland mail stage passes daily. A small mill was erected in 1864, which met with great success. It is again in operation, and is reducing ore which returns nearly $200 per ton. A mill of greatly increased capacity is about to be constructed, which will add largely to the production of bullion."[2]

NYE COUNTY.

This county includes a large unexplored area, and has not yet been surveyed and mapped with any accuracy. Its unknown stretches of wilderness and desert have been penetrated by a few explorers, and our knowledge of it is being rapidly increased. The indefatigable prospectors for silver and gold have already located many very promising veins, and have organized districts, but chiefly in the upper half of the county, north of the parallel of 38°, and between longitude 114° and 117° 30′. This county, together with Lander county, form what is known as eastern Nevada, which was well represented at the Exposition by a splendid collection of rich silver ores from the principal veins.

---

[1] From "La Nevada Orientale," p. 100. [2] Ibid., p. 98.

Between 30 and 40 mining districts have already been laid ou the following is as complete a list as can now be obtained:

A. In the Toiyabe range, south of Austin:

1. Blue springs.
2. North Twin river.
3. Twin river.
4. South Twin river.
5. Peavine.
6. Hot springs.
7. El Dorado.
8. San Antonio.
9. Marysville.

B. In the Smoky mountains, east of Toiyabe:

10. Northumberland.
11. Jefferson.
12. Philadelphia, or Silver Bend.
13. Manhattan.
14. Santa Clara.

C. In the Monitor range and Hot Creek range:

15. Danville, (Monitor range.)
16. Hot Creek.
17. Morey.
18. Empire.

D. In the eastern part of county:

19. Milk springs.
20. Reveille.
21. Pahranagat.
22. Worthington.

The following brief notices of the principal districts are taken from the descriptive publication upon eastern Nevada, circulated Exposition:[1]

Blue Springs district.—This is so named from a number of deep s or ponds of water which lie in the valley at the foot of the mou within this district. It contains a number of veins of quartz of lar reputed to be rich in silver, but so slightly developed that their tru is not really known. Being in the mountain range, so singularly silver and other metals, the district is, in all probability, as rich as surrounding it. Near this, in the great Smoky Valley, is the ext field of 2,000 acres of salt lands, from which is obtained the portion of the salt used at Austin and throughout the neighboring s for both domestic purposes and the reduction of ores. Upon th field, as on many others with which the State abounds, the sa as an efflorescence a half inch or more in thickness upon the of the ground, from whence it is carefully gathered. A sligl

[1] La Nevada Orientale.

causes the salt to disappear, but under the influence of the sun it soon reappears. Many hundreds of tons are obtained from the field annually, and the supply coming from deep springs seems to be inexhaustible. It is furnished for the use of mills at from \$30 to \$50 per ton.

North Twin River district.—"Forty miles south of Austin we reach the North Twin River district. Although this section of the country was examined and many claims located early in the settlement of the country, it was not considered of importance until within a year or two of the present time, when quite thorough work upon a number of veins has proved them of large size and most extraordinary value. Deep cañons, with running streams, open to the plain, afford access to the mines and sites for reduction mills. The mines of the La Plata and Buckeye companies are in this district, and it is from the developments of these that the estimates of the value of the district are founded. A large mill is in course of construction by the La Plata company, which, in a few months, will be adding to the stream of bullion already commenced to flow from the mining districts bordering the Smoky Valley. Other mills are in contemplation, and will probably be in operation before the expiration of the present year."

Twin River district.—The Twin River district is 50 miles south of Austin, and is at present regarded as the most important of the districts on the eastern slope of the mountain. It received its name from two very pretty streams (although not in the district) which flow into the valley, running side by side, only a few yards distant, never uniting, but sinking soon after reaching the plain. The principal mines of the district are situated in Ophir cañon, where a large and busy village has been built. The Murphy mine is the one most explored, and by its great production of bullion has given a high reputation to the section of country in which it is located. A costly and complete mill, connected with the mine, with steam power operating 20 heavy stamps, and with furnaces for roasting and chloridizing the ores, was completed in the fall of 1866, and has since been in successful operation, producing \$30,000 to \$60,000 monthly. It is expected that another mill will be erected during the summer in connection with the McDonald mine, which is on the same vein as the Murphy. The Wisconsin and other cañons in the neighborhood are similar in formation and general character to the Ophir, and contain silver-bearing veins of great promise. The ore of the district is tetrahedrite, with gold and silver predominant, and containing some base metals. It is generally rich, and an abundance is obtained, producing upwards of \$100 per ton. Water and wood are found in unlimited quantities in the mountains, and the soil of the contiguous valley is productive.

South Twin River, Hot Springs, El Dorado, and Peavine districts.—These districts succeed to near where the mountain range, which we have traced for 150 miles, falls away into the plain. They have been only slightly explored. The great Smoky Valley lies to the east of and between the range of districts which have been noticed, and the line of districts in the

Smoky mountain range. In the centre of the valley there are remarkable springs of hot water, throwing out a large and constant stream. "The basin of the spring is from 20 to 30 feet in diameter, and the fountain of boiling water rises in the centre, a constant column ascending by its subterranean force several feet above the surface. The water is excellent for all uses, and its great heat is found very convenient for domestic purposes."

San Antonio district.—San Antonio district, comprising the mountain of that name, is situated about 20 miles southeast of the southern terminus of the Toiyabe mountains, and about 90 miles from Austin. Several companies are at present engaged in successful mining, and large quantities of ore are extracted, which return, from reduction, an average of $200 per ton. The mountain is dry, barren, and broken, and for a depth of upwards of 200 feet, which has been reached, no water has been obtained. A few miles to the northwest are springs where two small quartz mills have been constructed. More vigorous work is now prosecuted upon the mines of this district than formerly.

Philadelphia or Silver Bend district.—On the eastern slope of the Smoky Valley range of mountains, and including a spur of them running to the southeast, about eighty miles south by east from Austin, is the district of Silver Bend or Philadelphia. Here have been found veins of great size, and exceedingly rich in silver. The chief discovery has been the single ledge called the Highbridge and the Transylvania. This, if a single ledge, has been traced and opened along a line for many thousand feet; it is described as always large, from five to seven feet in thickness, and as producing ore worth from $200 to several thousand dollars a ton. Specimens of the ore at the Exposition were assayed at the government bureau for the assay of minerals, under the direction of Professor Rivot, with the following results:

1. *Highbridge mine.*—Gray copper with sulphuret of copper and altered blue and green carbonate of copper, speckled with blende on ferruginous quartz. Assay in silver per ton of 2,000 pounds, $1,709 50.

2. *Transylvania mine.*—Sulphuret of copper, with blue and green carbonate of copper and mispickel on ferruginous quartz. Assay in silver per ton of 2,000 pounds, $2,794 68.

A portion of the vein became the property of David E. Buel, esq., who erected a small mill for the reduction of the ore, and in a few months produced bullion to the value of $100,000. The town of Belmont was soon built, and had a population of 1,000 miners.

The district of Northumberland is in the same range of mountains and 20 miles north of Belmont. Several tons of ore have been reduced to test the value of the veins and the product has been from $130 to $200 per ton, proving beyond dispute the value of the ore. The ledges are large and numerous.

Danville, Hercules, Hot Creek, and Milk Springs districts.—During the summer of 1866 thousands of square miles were explored and the districts of Danville, Hot Creek, Empire, Milk Springs and Reveille organized,

Hercules and Pahranagat had been previously formed. Hot Creek district receives its name from a singular stream of hot water flowing from several boiling springs, and forming a stream of several feet in breadth for two or three miles. It flows through a crack or chasm in the mountains, the walls of which rise 1,000 feet on either side. Limestone is the prevailing rock.

Empire and Milk Springs districts are in the Hot Creek range of mountains, and are respectively 20 and 40 miles south of Hot creek. They are but little developed.

Reveille district is 140 miles southeast of Austin, and in the range of mountains next east of Hot creek, from which district it is 35 miles southeast. Limestone is the prevailing rock, and it bears great masses of quartz rich in silver ores. They are located and regarded as veins, although quite irregular in appearance. The Antarctic is reported to be 56 feet thick; the August, 73 feet; the Crescent, 106; the Mediterranean, 60; the Atlantic, 40, and the National 45 feet thick. The following is the report of an assay made at the assay bureau of the French government upon a specimen from the collection sent to the Exposition:

Fisherman ledge.—Bullion Company, Reveille district. Quartz impregnated with altered copper, small specks of galena, and blende. Assay in silver per ton of 2,000 pounds, $1,713 46.

The district was organized in 1866, and had a mill of five stamps in successful operation.

Pahranagat district.—This district is located in the eastern part of the county, in a lofty range of mountains running nearly north and south. It is 50 miles east of Reveille district, and is about 150 miles north of Callville, upon the Colorado river. It was located in March, 1865, but, owing to distance from supplies and the presence of hostile Indians, a permanent settlement was not effected before October, and, during 1866, from 100 to 200 men were engaged there in prospecting and mining. The number of mining locations on record, in 1866, was about 1,000, and the claims extended over a belt of country five miles long by about three wide. The altitude is about 5,000 feet above the sea. The principal mines lie on the southern and eastern slopes of Mount Irish, which is composed of a whitish porphyritic rock, with dark colored limestone on the flanks, (abounding in crinoids and corals,) overlying slates, and capped with a heavy bed of quartzite.[1]

The veins are numerous and vary greatly in width, but in 1866 they had not been much worked or opened. Their general direction is northeast and southwest.

ESMERALDA COUNTY.

This county, occupying the southwestern corner of the State, and bordering upon California, is rich in gold and silver-bearing districts, of which the following is a list:

Aurora section—Esmeralda, Masonic, Van Horn, Montgomery, Pahdet,

[1] This notice is condensed from the report of R. H. Stretch, the State mineralogist. (1866.)

Thunder Spring. Blind Springs district and Bodie district adjoin the others, but are in California.

Walker Lake section—Lake district, Walker River, Cornell, Desert.

· Eastern and southern section—Excelsior, Cottonwood, Minnesota, Palmetto, Red Mountain, Silver Peak.

Esmeralda district.—Located in 1860, and for a long time one of the most prominent mining districts of the State. The claims known as the Wide West, Real del Monte, Pond, Antelope, and others, were worked with considerable energy, and produced a large amount of bullion; but a few years ago the yield rapidly diminished, and owing to this and great excesses in speculations in mining property the district became unpopular and neglected. Costly mills erected in the vicinity are now mostly idle.

The veins are quartzose, and traverse a hard porphyry in irregular seams and bunches, forming a kind of stockwork. Large bunches or pockets of exceedingly rich ore were found in the Wide West and Real del Monte claims. The bullion contains a large percentage of gold. The bullion produced from the ores of Bodie district, in California, is in great part, at least, taken to Aurora for assay and is shipped from there.

Specimens of some of the ores of this district were exhibited in the collection from California.

Pahdet district.—This is a newly organized district, dating from the spring of 1866, and is southeast of Aurora, towards the White mountains. It is interesting as affording very rich specimens of copper glance in quartz, with free gold in large grains, and some combined silver. (Specimen No. 63 in the California collection.)

Walker River, Lake, Desert, and Wilson's districts.—These are located upon the western shore of Walker lake, and are about 15 miles east of Wellington's station, on the west Walker river. In Wilson's district there are veins of quartz containing free gold and no silver. Near Walker river rich copper-bearing veins are found which contain both gold and silver.

Red Mountain district.—This is in the extreme southern point of the county, near the line of Nye county and the California line. It is remarkable for an enormous quartz vein which bears free gold, and which outcrops upon the side of a mountain in such a position that it can be rapidly and cheaply mined, and it exposes a large amount of good ore. The veins are not yet developed.

Silver Peak district.—This lies immediately east of, and was formerly included in, Red Mountain district. There are numerous claims upon veins of silver ore of great richness, but none of them yet extensively developed or worked. These veins are interesting for their nearly horizontal position, and they appear to be contact deposits between a thickly bedded yellowish limestone, or dolomite, and granite. The Pocotillo series, the Vanderbilt, and the Sisson claims are prominent among those which have been partially opened.

The Vanderbilt claim was represented in the Exposition by specimens in the collection sent from eastern Nevada, and a portion was assayed at the government bureau of assays under the direction of Prof. Rivot, with the following results, according to the extract from the official register:

Vanderbilt mine.—Silver Peak and Red Mountain.—Quartz, impregnated with gray copper, with altered green and blue carbonate of copper, yellow hydrated oxide of iron, specks of galena, and perhaps sulphuret of silver.

Silver, per cent. 2.370; value per ton, $687 30; gold, per cent. 0.008.

The geology of this district is extremly interesting, as granite, trap dikes, yellow limestone and blue fossiliferous limestone, probably Silurian, and black slates are found in close proximity; while recent volcanic cones and deposits of salt, sulphur, and alum are found in the valleys.

CHURCHILL COUNTY.

The following mining districts have been organized in this county: Mountain Wells, Silver Hill, Clan Alpine, Desert, Augusta, Salina, Alamo, New Pass, and Ravenswood.

HUMBOLDT COUNTY.

A great number of mining districts were organized along both slopes of the Humboldt or Star Mountain range, in this county, and several thousand locations of claims were made and recorded, but only a few of these claims have produced any notable amount of ore or bullion. The principal districts are Prince Royal, Humboldt, El Dorado, Echo, Sacramento, Santa Clara, Star, Buena Vista, Indian, American, Sierra, Alabama, Pine-wood, Table Mountain, Cinnabar, Ohio, Columbia, Oro Fino, and Harmony. The Pueblo, Vicksburg, and Black Rock districts are in the northern part of the county, and their exploration and settlement has been retarded by Indian difficulties.

Sheba mine, Star district.—Perhaps the most prominent mine of the county is the Sheba, near Star City, in Star district, which a few years ago yielded a large quantity of very rich ore, but of a refractory nature, being composed in great part of argentiferous gray copper, mixed with sulphuret of antimony. Failing in the reduction of this ore by the ordinary processes, the richest ore was sent to England to be smelted. The aggregate yield of the mine has been about $70,000. In the development and working of this claim 3,000 feet of tunnels and drifts have been run, at a cost of $75,000. The ore was found in irregular bunches or deposits, in metamorphic strata of the Secondary period, and does not appear to be in a regular vein. The principal bunches of ore have been removed, and the mine has since been unproductive.

De Soto claim, Star district.—Similar ore has been found in the De Soto

claim, in the vicinity. About 1,000 feet of tunnel has been run upon this claim, and about 200 tons of ore taken out, worth $100 per ton.

Gem of the Sierras mine, Sierra district.—This claim is located five miles east of Dunglen, in limestone. It affords very rich ore, some of it assaying $16,000 in silver per ton. An incline shaft has been sunk to a depth of 80 feet, and drifts have been run to an aggregate of 350 feet. In doing this work 178 tons of ore were taken out, which was worked by the ordinary pan process, and yielded $31,000, or at the rate of $175 per ton.[1]

Tallulah mine.—This claim is one and a half mile west of Dun Glen, and is in the outer hills of the first mountain range east of Star mountain. There are two or more lodes, well defined, trending north and south, and dipping to the west at about 45 degrees. These are cut by a tunnel 500 feet long. The ore is in some respects similar to that from the Sheba, and is characterized by a large amount of antimony. It also contains some native silver, and in general is very rich, some of it having yielded $1,000 per ton. About 50 tons of first-class ore had been taken out in 1865.

Montezuma mine, Trinity district.—The vein in this claim is interesting for the large amount of antimony and lead it contains. The ore is said to yield an average of $75 per ton in silver. By smelting, it yields $90 per ton, and 48 per cent. of lead and antimony.

TABULAR STATEMENT OF THE RESULTS OF THE ASSAYS OF ORES SENT TO THE PARIS EXPOSITION FROM EASTERN NEVADA.

The following statement of the results of the assays of ores from eastern Nevada was published and circulated at the Exposition in connection with the little work entitled *La Nevada Orientale.* It is given exactly as printed, with the exception of the correction of a few typographical errors. There appears to be a discrepancy, in some instances, between the percentage amounts and the value given in the translation:

Extrait des registres du bureau d'essai pour les substances minérales.

Paris, le 1er Août 1867.

ONZE MINERAIS D'ARGENT, PROVENANT D'AUSTIN-NEVADA, REMIS PAR M. GRUNER, INSPECTEUR GÉNERAL DES MINES.

1. *Highbridge Mine.*—Cuivre gris avec cuivre sulfuré et altérations de cuivre carbonaté vert et bleu, mouches de blende sur quartz ferrugineux.

Argent 0/0 .... 4.535
Or 0/0 .... 0.000

Extract from the register of the bureau of assay of minerals.

Paris, August 1, 1867.

ELEVEN SPECIMENS OF SILVER ORE COMING FROM AUSTIN, NEVADA, U. S., RECEIVED FROM MR. GRUNER, INSPECTOR GENERAL OF THE MINES OF FRANCE.

1. *Highbridge Mine.*—Gray copper with sulphuret of copper and altered blue and green carbonate of copper, speckled with blende on ferruginous quartz.

Assay in silver per ton of 2,000 pounds $1,709 50

[1] Report of Hiram Welch, county assessor, 1865.

2. *Transylvania Mine.*—Cuivre sulfuré avec cuivre carbonaté vert et bleu; mouches de blende et de galène cuivre gris et mispickel sur quartz ferrugineux.

Argent 0/0	1.405
Or 0/0	0.000

3. *Vanderbilt Mine.*—Silver Peak et Red Mountain Co, étiquette Pocotillo.—Quartz imprégné de cuivre gris avec altération de cuivre carbonaté vert et bleu. Fer oxydé hydraté jaune, mouches de galène et peut-être argent sulfuré.

Argent 0/0	2.370
Or 0/0	0.008

4. *FishermanLedge.*—Bullion Co.,Reveille District.—Quartz imprégné d'altérations cuivreuses, faibles mouches de galene et de blende.

Argent 0/0	4.545
Or 0/0	0.0005

5. *Chase Mine.*—Yankee Blade.—Roche quartzeuse grise imprégnée d'argent sulfuré, d'argent natif, d'argent gris, de cuivre gris avec cuivre pyriteux.

Argent 0/0	6.250
Or 0/0	0.00025

6. *Great-Eastern Mine.*—Argent gris, argent rouge, peut-être, argent sulfuré, cuivre pyriteux en grains cristallins très-petits, pyrite de fer, mouches de galène sur quartz.

Argent 0/0	9.280
Or 0/0	0.00250

7. *Florida Mine.*—Argent gris avec argent rouge sur quartz.

Argent 0/8	11.170
Or 0/0	0.0005

8. *Timoke Mine.*—Argent gris avec argent rouge et cuivre gris sur quartz.

Argent 0/0	14.100
Or 0/0	0.001

9. *Manhattan Mine*—North Star Mine.—Argent rouge, argent gris avec mouches de pyrite de fer sur quartz.

Argent 0/0	4.710
Or 0/0	0.0005

10. *Diana Mine.*—Cuivre gris avec pyrite de fer et de cuivre, mouches de galène sur quartz avec un peu de feldspath rose.

Argent 0/0	6.930
Or 0/0	0.000

2. *Transylvania Mine.*—Sulphuret of copper, with blue and green carbonate of copper and mispickel on ferruginous quartz.

Assay in silver per ton of 2,000 pounds $2,794 68

3. *Vanderbilt Mine.*—Silver Peak and Red Mountain.—Quartz, impregnated with gray copper, with altered green and blue carbonate of copper, yellow hydrated oxyde of iron, specks of galena and perhaps sulphuret of silver.

Assay in silver per ton of 2,000 pounds $687 30

4. *Fisherman Ledge.*—Bullion Co., Reveille District.—Quartz impregnated with altered copper, small specks of galena and blende.

Assay in silver per ton of 2,000 pounds $1,713 46

5. *Chase Mine.*—Yankee Blade.—Gray quartz rock impregnated with sulphuret of silver, native silver, gray silver and gray copper, with copper pyrites.

Assay in silver per ton of 2,000 pounds $2,356 50

6. *Great Eastern Mine.*—Gray silver, ruby silver, perhaps sulphuret of silver, gray copper, copper pyrites in very small crystalline grains, iron pyrites, specks of galena on quartz.

Assay in silver per ton of 2,000 pounds $3,498 50

7. *Florida Mine.*—Gray silver, with ruby silver, and gray copper on quartz.

Assay in silver per ton of 2,000 pounds $4,211 09

8. *Timoke Mine.*—Gray silver, with ruby silver and gray copper on quartz.

Assay in silver per ton of 2,000 pounds $5,349 63

9. *Manhattan Mine.*—North Star Mine.—Ruby silver, gray silver, with specks of iron pyrites on quartz.

Assay in silver per ton of 2,000 pounds $1,365 90

10. *Diana Mine.*—Gray copper with iron and copper pyrites, specks of galena on quartz, with a little rose-colored feldspar.

Assay in silver per ton of 2,000 pounds $2,612 61

11. *Fairmount Mine.*—Twin river.—Galène à facettes curvilignes, cuivre gris, mispickel, mouches de blende sur quartz.

Argent 0/0	0.180
Or 0/0	0.00025

(Signed) L'Ingénieur en chef des Mines
Directeur du Bureau des essais.
L.-E. RIVOT.

11. *Fairmount Mine.*—Twin ri
ena with curvilinear faces, gra
mispickel, specks of blende on qu

Assay in silver per ton of 2 pounds	$6

(Signed) Chief Engineer of Mi
Director of Bureau
L.-E. 1

REDUCTION WORKS IN NEVADA IN 1866.

According to the tabular statement presented on the followi there were 85 quartz mills for the reduction or treatment of sil gold ores in the State of Nevada in 1866. Most of these were p by steam. They had an aggregate of 1,260 stamps, and co $6,000,000.

Nearly all the machinery of these establishments, the stam breakers, pans, concentrators, etc., was made in San Franci carted across Sierra Nevada in wagons.

Table of quartz mills in the State of Nevada in 1866.

[From Langley's Pacific Coast Business Directory.]

Location.	Name of mill.	When erected.	No. stamps.	Power.	Cost.[1]	Occupants or owner in 1866.
CHURCHILL COUNTY.						
Averill	Connecticut	1865	15	Steam	$100,000	Conn. Mill and Land Co.
Clan Alpine	Clan Alpine	1865	10	...do	100,000	Clan Alpine M. & M. Co.
La Plata	Silver Wave	1865	10	...do	100,000	Silver Wave M. & M. Co.
	Desert	......	5	...do	100,000	
ESMERALDA COUNTY.						
Aurora	Alturas	......	7	Steam	....	
Do	Antelope	1862	8	...do	100,000	
Do	Aurora	1863	16	...do	40,000	
Do	Gibbons	......	4	...do	....	
Do	Independence	1863	16	...do	60,000	J. D. Winters.
Do	Napa	......	8	...do	....	
Do	Pioneer	......	8	...do	....	
Do	Real del Monte	1863	30	...do	150,000	
Do	Red Mountain	......	3	...do	....	
Do	Union	1862	8	...do	10,000	J. J. Poor.
Do	Wide West	1862	16	...do	75,000	Wide West M. & M. Co.
Pine Creek	Pine Creek	1862	10	...do	15,000	
Silver Peak	Martin & Co	......	16	...do	4[illegible],000	S. B. Martin & Co.
Do	New York and Silver Peak.	......	10	....	....	New York and Silver Peak M. & M. Co.
HUMBOLDT COUNTY.[2]						
Dun Glen	Auld Lang Syne	1864	8	Steam	30,000	Auld Lang Syne M. Co.
Etna	Nason's	1865	......	...do	35,000	A. W. Nason.
Do	Stevenson's	1865	10	...do	60,000	Nevada S. M. Co.
Genaca Bridge	Holt's	1866	4	...do	20,000	G. W. Holt.
Oreana	Webber's	1865	10	...do	35,000	Nevada S. M. Co.
Puebla	Puebla	1865	8	...do	20,000	
Star City	Sheba	1863	10	...do	6[illegible],000	G. Faulkner.
Do	Old Sheba	1863	10	Water	30,000	
Unionville	Pioneer	1862	8	...do	30,000	Pioneer and Inskip M. and M. Co.
LANDER COUNTY.						
Austin	Boston and Nevada.	1865	10	Steam	80,000	
Do	California	1863	10	...do	75,000	
Do	Long Island	1863	5	...do	40,000	
Do	Manhattan	1864	20	...do	100,000	
Do	Pioneer	1863	20	...do	100,000	
Do	Silver Hill	1866	5	...do	50,000	
Do	Union	1863	10	...do	70,000	
Do	Ware	1865	5	...do	40,000	
Big Creek	Eureka	1865	10	...do	60,000	
Do	Parrott	1865	15	...do	80,000	
Do	Phelps	1864	10	Water	30,000	
Bute cañon	San Francisco	1865	8	Steam	40,000	
Cortez	Cortez	1864	16	...do	90,000	
Egan cañon	Hope	1865	5	...do	30,000	
Do	Social Company	1865	5	...do	35,000	
Do	Steptoe	1865	20	...do	100,000	

[1] The estimate of the assessors for the machinery; value of mine not included.

[2] Webber's mill at Oreana has smelting furnaces, with capacity of 15 to 20 tons per day. The Humboldt River Mill and Mining Company are preparing [1866] to erect a fine 10-stamp mill near Dun Glen.

Table of quartz mills in the State of Nevada in 1866—Continued.

Location.	Name of mill.	When erected.	No. stamps.	Power.	Cost.	Occupants or owners in 1866.
Emigrant cañon	Keystone	1865	20	Steam	$95,000	
Kingston	New England and Nevada.	1866	20	....do	100,000	
Do	Stirling	1865	20	Water	100,000	
New York cañon	Metacom	1866	20	Steam	50,000	
Telegraph cañon	Midas	1865	15	....do	120,000	
Yankee Blade	Confidence	1865	10	....do	100,000	
Do	Empire	1866	10	....do	60,000	
LYON COUNTY.						
Carson river	Eureka	1861	20	Water	65,000	Dunbar, Hurd & Co.
Do	Franklin	1861	10	Steam and water.	35,000	Bank of California.
Do	Hydes			Water	5,000	W. B. Hyde.
Do	Island	1862	10	Steam and water.	35,000	C. A. Hill.
Do	Lindauer & Hirschman's.		15	Water	80,000	Lindauer & Hirschman.
Do	Ophir No. 1	1864	10	Steam and water.	20,000	Ophir M. & M. Co.
Do	Ophir No. 2		24	....do	75,000	Do.
Do	San Francisco	1861	10	....do	35,000	C. A. Shad & Co.
Como	Palmyra	1864	10	Steam	15,000	
Dayton	Birdsall & Carpent'r	1865	30	Water	45,000	Birdsall & Carpenter.
Do	Daney	1863	15	Steam	55,000	Daney G. & S. M. Co.
Do	Dayton No. 1	1861	16	Water	50,000	J. D. Winters & Co.
Do	Dayton No. 2	1864	20	Steam	40,000	Do.
Do	Dayton Reduction Works.		15	....do	15,000	R. Helm & Co.
Do	Golden Eagle	1861	15	....do	35,000	Rule & Co.
Do	Illinois	1864	15	....do	35,000	Bank of California.
Do	Gould & Curry		80	....do	950,000	Gould & Curry S. M. Co.
Do	Hoosier State		8	....do	40,000	J. C. Clarke.
Do	Lands		20	....do	60,000	Charles Land.
Do	Mariposa		13	....do	20,000	Davis & McCurdy.
Do	Ogden		22	....do	50,000	Ogden, Carey & Co.
Do	Rodgers		10	....do	25,000	Rodgers S. M. Co.
Do	Summit		20	....do	50,000	Summit Mill Co.
Do	Suncook		16	....do	35,000	Bassett & Co.
Do	Winfield		18	....do	80,000	L. A. Booth.
WASHOE COUNTY.						
Franktown	Dallas		60	Steam and water.	250,000	J. Dall & Co.
Ophir	Ophir		72	Steam	500,000	Ophir M. & M. Co.
Pleasant valley	Napa		20	Steam and water.	80,000	James Hill & Co.
Do	Temelie		15	....do	75,000	W. C. Wallace.
Truckee Meadows	English county		20	Water	100,000	W. C. G. & S. M. Co.
Washoe	Atchison		20	Steam and water.	80,000	L. Tevis.
Do	Buckeye		10	Steam	50,000	L. Mason.
Do	Manhattan		24	Steam and water.	100,000	New York and Nevada G. and S. M. Co.
Do	Minnesota		16	....do	75,000	Savage M. & M. Co.
Do	New York		24	Steam	111,000	N. Y. & W. M. & M. Co.

CALIFORNIA.

discovery of silver ore in California dates from 1854, when a mass of t of silver, (Hessite,) a rare mineral, was found in the gold washings eorgetown in El Dorado county,[1] but all endeavors to find a vein sit there have been unsuccessful. The portion of the State lying the crest of the Sierra Nevada, and bordering upon the State of , has several districts already noted for their rich veins of silver, very extensive developments of the veins have yet been made, production of silver bullion is not yet large. The eastern range t of the Sierra Nevada, bordering the long valley occupied by river and lake, is perhaps the principal silver region.

following is a list of the districts that have been organized in that . Commencing at the north, and giving the names of the districts order towards the south, we have, on the western slope of the mountain and Inyo range: Columbus, Slate mountain, Mont-, Lone Pine, Keyes, Inyo, Russ, Coso, Argus, Union, Telescope, da Springs. (The four last named are beyond the limits of Owen's)

he opposite side of Owen's river valley, and on the eastern slope Sierra Nevada range, commencing as before, on the north: Blind s, Big Pine, Kearsarge, and Alabama.

further south is the Slate Range district, once quite noted as the of the Antrim lode and other veins containing much chloride of but now, and for two or three years past, practically abandoned. of Blind Springs and Montgomery districts are Bodie Bluff, in ounty, and Silver Mountain, Monitor, Mogul, Webster and Alpine s, in Alpine county. Recently, in the spring of 1867, some very e was discovered in a large vein called the Chicago in Shasta , west of the Sierra Nevada, and in the northern part of the State. in is reported to be quite large, and the ore abundant. It was nted by several specimens in the California collection, (Nos. 54 to his ore is a mixture of argentiferous gray copper and argenti-galena, and is admirably adapted to smelting.

r veins of silver ore have been found in the southern part of the what is known as the Macedonian district in San Bernardino , represented in the Exhibition by a specimen presented by Mr. euse from the Magenta lode. (No. 53 of the Catalogue.)

e San Gabriel mountains, Los Angeles county, about 25 miles s Angeles, a vein of argentiferous gray copper has been opened Winston. This is a region, together with a broad area north of t but very imperfectly explored, there being large tracts of coun-which the topography is scarcely known.

Springs district.—This district at the present time is one of the in silver of the State of California, and was represented in the

[1] *Vide* Report of a Geological Reconnaissance in California, p. 274.

Exp ion by specimens from the following claims: Camanche, Josephine, Rockingham, and Diana. The Camanche specimen weighed about 100 pounds, and was contributed by Dr. Harkness and Dr. Frey, of Sacramento. The mass contained a large amount of silver in a state of admixture with antimonial ochre and green carbonate and silicate of copper. Chloride of silver, and perhaps bromide, was also present, and the whole mass had a dark greenish black color. The other ores were somewhat similar, but contained more of the chloride of silver, in visible crusts. These veins are not very wide, usually from six inches to two feet, and they traverse granite. The ore, however, is exceedingly rich, and yields up the silver readily by smelting.

Dr. Partz, who represents a New York mining company, has erected smelting furnaces, and produces a considerable amount of rich bullion, but no statistics have been received. A thriving village, called Partzwick, has grown up about these mines and smelting works.

Kearsarge district.—The veins for which this district was organized are situated in one of the highest peaks of the Sierra Nevada, known as Kearsarge mountain, a few miles west of the United States military station, Camp Independence. This mountain is composed of granite and slates, all metamorphosed, and is cut by veins up to the height of 10,000 feet or more.

The principal claims represented by specimens in the Exposition were the Kearsarge and the Silver Sprout. The latter crops out boldly at a great height upon the mountain, and contains some very rich ore charged with sulphuret of silver and native silver. It appears to be an ore that can be readily and cheaply worked. The Kearsarge claim is lower down the mountain and has also some very rich ores, but they appear to contain more galena and to be more difficult to work. Two or more mills are erected in the cañon below these claims.

Other veins of some promise, but not yet much opened, are the Mountain Sheep, Montezuma, and Pillar.

Inyo, Russ, and Coso districts.—These districts adjoin in the Inyo mountain range, the first east of the Sierra Nevada. The specimens in the Exposition, Nos. 69–73, were chiefly from the Eclipse claim. The ores are a mixture of silver, copper, and lead minerals. The Buena Vista lode, and the San Rafael, were represented by some very rich ores. Most of the veins of this district are characterized by containing large amounts of lead ore, either as galena or the secondary compounds resulting from its surface decomposition, such as the carbonate and the sulphate of lead. The attempts which have been made to work these ores in the ordinary way, by grinding in iron pans, were of course failures, and the mills which were built are idle or in ruins. Some attempts have since been made to smelt the ore, but the presence of roving hostile s ages, and other difficulties, have hitherto prevented the development the undoubted riches of the region. A new district called Cerro Gord reported, and the principal claims are the San Lucas, the Buena Vis and the Bismarck.

IDAHO.

The great silver region of Idaho is in the southwestern corner of the Territory, in the Oro Fino mountain range, the divide between the Owyhee and Snake rivers, and about 450 miles southwest of Boise City. The rocks are granite and the veins numerous and parallel, trending nearly northeast and southwest. They have the appearance, in specimens, of being fissure veins, not generally of great width, but of extreme richness in silver and gold, giving bullion worth from $3 to $8 per ounce. The outcrops contain more gold than the rock below, which has not been decomposed by the action of the air and moisture, and which carries a large portion of silver. This is well shown by the following assays of two samples, one from near the surface in the lode known as the Oro Fino, yielded at the rate of $2,016 24 per ton in gold, and $425 03 in silver; total value $2,441 27. The other sample was from the Morning Star lode, near the water level, and gave at the rate of, per ton, gold, $310 19, and silver $2,216 39; total, $2,526 58. The only vein of this important region known by the writer to have been represented by specimens or statistics in the Exposition was the celebrated Poorman lode, of which the following is a short description:

Poorman lode.—This vein has become celebrated throughout the Pacific coast mining regions for the large quantities of extremely rich silver ore and native silver which it has yielded. Red or ruby silver ore occurs in large masses, together with chloride of silver in broad sheets and crusts, often beautifully crystallized. Native gold occurs also sparingly with the native silver in the partly decomposed ores.

Several blocks of the rich ore from 18 inches to two or three feet in length, and weighing several hundred weight, were exhibited at the Exposition in the central pyramidal mass of ores in the United States section. The remarkable interest and value of the exhibit was recognized by the award of a gold medal.

The Poorman claim is 1,600 feet in length upon the course of the lode. Of this the New York and Owyhee Gold and Silver Mining Company owns 1,142½ feet. Under this organization the mine was re-opened July 23, 1866, and work was continued upon it until October 23, being a period of three months. During this time about 15 tons of first-class selected ore were taken out, and this was packed in boxes and shipped to New York to be smelted at Newark. It was found by calculation that the expense of transportation would not be greater than the costs of treatment in Idaho, while the greater product by more careful reduction at Newark gave a larger profit. In addition to this production of rich ore, 2,382¾ tons of second and third-class ores were raised and worked at four mills, producing in refined bullion $546,691. The total cost of mining, hauling, milling, melting, assaying, and refining, with the revenue tax added, was $156,440, leaving the sum of $390,251 as the net proceeds, to which should be added the product of the 15 tons of rich

ore sent to Newark, a part of which was reserved for exhibition at Paris The details regarding the production and costs, together with the average and net yield of the ores per ton, are shown in the following statement from the report of Mr. Wells D. Walbridge, made to the company in March, 1867:

Results of working Poorman mine from July 19 to November 1, 1866.

Name of mill.	Tons crushed.	Crude bullion.	Refined bullion.	Value of bullion.	Average of bullion per ton.	Remarks.
		Ounces.	*Ounces.*			
Jackson mill	369¼	7,860 20	7,323 29	$25,200 48	$68 25	Mostly third class gold rock.
Ainsworth mill	362¼	34,592 53	33.178 52	62,220 81	171 88	87¾ tons third class; 274½ tons second class.
New York and Oro Fino mill.	771¼	129,542 51	116,753 91	203,586 71	264 05	40 to 50 tons third class; balance second class.
New York and Owyhee mill.	880	156,394 25	147,960 17	255,683 59	301 91	All second-class rock.
Total value				$546,691 59		

Whole amount of rock produced and sent to mills.

New York and Oro Fino Gold and Silver Mining Company, accounted for	750¾
New York and Oro Fine Gold and Silver Mining Company, not accounted for	20½
Ainsworth Milling Company, as above	362¼
Jackson Mill Company, as above	369¼
New York and Owyhee Gold and Silver Mining Company, as above	880
Total tons	2,382¾

Cost of hauling 1,133½ tons to Sinker creek, at $8	$9,068 00
Cost of hauling 1,249¼ tons to Jordan creek, at $6 50	8,120 12
Total cost of hauling	$17,188 12

Cost of milling 362¼ tons at Ainsworth mill	$13,170 47
Cost of milling 750¾ tons at New York and Oro Fino mill.	30,030 00
Cost of milling 369¼ tons at Jackson mill	11,082 07
Cost of mining 880 tons at New York and Owyhee Gold and Silver Mining Company	35,200 00
Cost of milling 20½ tons at New York and Oro Fino Mining Company (balance)	820 00
Total cost of milling	$90,302 54

Total expenses at mine for labor, supplies, lumber, timber, &c., less profit on money, \$3,286 99	\$38,707 74
Cost of refining and assaying bullion	7,250 01
Internal revenue tax, in gold	2,991 78
Net proceeds of 2,382¾ tons of rock crushed	\$390,251 20
Value of bullion per ounce, refined, Jackson mill	\$3 $44\frac{11}{100}$
Value of bullion per ounce, refined, Ainsworth mill	1 $87\frac{53}{100}$
Value of bullion per ounce, refined, New York and Oro Fino mill	1 $74\frac{38}{100}$
Value of bullion per ounce, refined, New York and Owyhee mill	1 $72\frac{80}{100}$
Average yield of all rock crushed, per ton	229 41
Net yield of all rock crushed, per ton	163 34
All charges for mining, milling, &c., per ton	66 07

The vein outcrops along the slope of a hill, and is reached by shafts and tunnels to the depth, in 1866, of 150 feet, and now, probably, (1867,) to a depth of 258 feet, by the completion of a lower tunnel 1,401 feet long. The best ore appears to be confined to one principal shoot or chimney between the north and south shafts, about 150 feet apart. No statistics for 1867 have been received.

STAMP MILLS IN IDAHO.

The number of stamp mills in operation in September, 1866, was 32, of which about three-fourths were propelled by steam. The aggregate number of stamps was 357, and the cost of erection was estimated at nearly \$1,500,000.

The following is a list of the quartz mills in the Territory in 1866, with their location, name, and number of stamps:

Location.	Name of mill.	Number of stamps.
ALTURAS COUNTY.		
Bear creek	Idaho	12
Bear creek	Waddingham Gold and Silver Mining Co.	10
Clifton	Waddingham Gold and Silver Mining Co.	40
Elk creek	Pittsburg and Idaho Gold and Silver Mining Co.	10
Red Warrior creek	Harris & Benson	10
Red Warrior creek	New York and Idaho Gold and Silver Mining Co	10
Red Warrior creek	Victor Gold and Silver Mining Co	20
Volcano	Defrees	10
Yuba district	Bledsoe	10
BOISE COUNTY.		
Centreville	Raymond's	10
Divide	Summit Flat	8
Elk creek	Elk Horn	5
Grime's creek	Bibbs, Jackson & Humason	8

List of quartz mills, &c.—Continued.

Location.	Name of mill.	Number of stamps.
BOISE COUNTY—Continued.		
Idaho City	Combs & Co	10
Idaho City	Middleton	10
Ice House gulch	Collins & Holliday	12
Moore's creek	Cobden Mining Co	25
Moore's creek	Gates	....
....	Van Wyck	5
....	Langdon's	....
OWYHEE COUNTY.		
Golden creek	Lincoln	20
Jordan creek	Cosmos	10
Jordan creek	Martin & Co	20
Jordan creek	Minear	5
Jordan creek	Morning Star	8
Jordan creek	New York and Oro Fino	10
Jordan creek	New York and Owyhee	20
Jordan creek	Shoenbar	10
Jordan creek	Vass & Morse	4
Sinker creek	Ainsworth	10
Sinker creek	Grenzeback	10
....	Webfoot	5

COLORADO.

There is evidence that Colorado will soon become celebrated for its silver as well as gold regions. It is asserted that not only large veins of argentiferous galena, but the true silver ores, such as the sulphurets, antimonial silver, and rich chloride, have been found in veins on the west side of the mountain range.

According to Mr. J. P. Whitney, the commissioner from the Territory to the Exposition,[1] "silver is found in all the gold mining districts of Colorado, associated with the ores containing gold; in the galena particularly, which is found at times in considerable quantity. It is always present, but not sufficiently plentiful to be a feature of value in the gold mines; yet large masses have lately been obtained by the smelting process from ores considered strictly gold bearing, and it is quite evident that in the future, with the advantages of improved processes, this metal will be freely obtained. But not until within the last two years was it generally known in Colorado that immense belts of silver veins, separate from the gold, existed upon the western declivities of the Rocky mountain range, corresponding in their direction and general features with those of gold upon the eastern side. The prevailing great richness in silver in the ores of Griffith and Argentine districts, in Clear Creek

[1] Colorado and its Ores at the Paris Exposition.

county, upon the head-waters of South Clear creek, some 13 miles distant from the towns of Central and Black Hawk, and correspondingly near to the snowy peaks of the range, first attracted particular attention to the ores of silver. In these districts silver ores of great richness have been discovered, masses being exhibited at the Paris Exposition from the Baker lode of Argentine district, and of the Elijah Hise and Indigo lodes of Griffith district, which assay respectively in silver alone $532 12, $1,656 20, and $1,804 83 to the ton of 2,000 pounds of ore. These veins were followed to an altitude previously unknown in mining experience in Colorado. Enterprising men were soon engaged in prospecting the corresponding regions upon the other side of the range, which resulted in the discovery of immense deposits of rich argentiferous galena. The black sulphurets of silver, antimonial silver ore, rich chlorides, ruby silver ore, and pieces of native silver, were found, and a new region, the extent of which has not yet been determined, was thrown open to the attention of all those who might have the curiosity to examine it.

"That portion of the silver region first opened is situated in Summit county, upon the head-waters of the Snake and Swan rivers, which flow into the Blue river, a tributary of the Rio Colorado, which flows into the Gulf of California. An examination of the region a few miles southwest, in the neighborhood of Ten Mile creek, another tributary of the Blue, led to the discovery of still more wonderful exhibits of mineral wealth than were found in the Snake river region. Veins of great width and prominence were found, which, in some instances, could be distinguished by their discolored surface ores, when miles distant, seaming the mountain-sides like gigantic roads, measuring from 20 to 50 feet in width."

A later publication[1] by the same author states that "the commencement of the great belt of silver mines in Colorado is apparently in Griffith and Argentine districts in Clear Creek county. From those districts the lodes are distinctly traced southwest for more than a distance of 30 miles. In the districts of Griffith and Argentine, where the mines are situated at a height between 8,000 and 10,000 feet above the level of the sea, the silver veins, though plentiful and of great richness, have not the prominence and width found upon the belt in its continuation southwest. In Snake River district the veins are found equally, if not more plentiful, but having on the average more than double the width of those in the Argentine district. In Ten Mile district, particularly upon Fletcher mountain, the veins are characterized by a width and regularity not yet observed elsewhere upon the Silver belt. Such is the richness of some of the surface ores, that specimens can readily be found upon many of the veins which yield large globules of native silver when submitted to a strong heat. In the immediate vicinity of Fletcher moun-

[1] November, 1867; immediately after the return of Mr. Whitney from the Territory.

tain many silver nuggets have been found; also quantities of quartz, showing native silver, and all the evidences point most conclusively to the existence of large and rich deposits of silver ore, which can only be obtained by systematic development of their recesses.

"The known silver mines are now easily reached by a series of roads, which have been built during the past two years, and settlements are rapidly being made upon them. In the vicinity of the silver mines nearest to the gold mines, a town has been built (Georgetown) within a very short time, containing a population of 2,500 souls, where reducing works have been run during the past summer with great success. Unlike the first attempts made in Colorado to save gold, the silver works have been successful from the start. The works of Garrott, Martine & Co., at Georgetown, of very simple construction and small capacity, have given in the past few months over two tons of silver, and have been running upon ore that has yielded from $200 to $1,000 per ton coin value. The works at Georgetown are insufficient to work more than a small quantity of the ore offered, and extensive arrangements have been made by various parties to put up additional works the following year. The prediction is made by the writer, that however large the yield of gold from Colorado will be in a few years, it will be equalled if not surpassed by the yield of silver.

"The result attained by sending Colorado gold ore to the Swansea works in Wales has proved not only the great richness, but that the ore can be easily and economically worked. The 70 tons of ore sent, averaging by assay 8 per cent. of copper, 18 ounces of silver and 9 ounces of gold per ton, yielded a sum sufficient to pay the heavy expenses of teaming six hundred miles over the Plains to the Missouri river, freights from the river to seaport, and by vessel to Swansea, all expenses of working, commissions, &c., and a surplus exceeding $6,000, in currency.

"The perfected process of Swansea is now being introduced into Colorado, and this winter will demonstrate its success there."

Argentiferous galena is found in many of the gold veins, but is more abundant in "Ten-Mile district, Summit county, than in any other section yet known. In that district it is, in some instances, found projecting in large masses above the surface of the earth, upon the line of vein, and can be detached in a partially oxidized condition, in pieces weighing from 500 to 1,000 pounds. Upon Fletcher Mountain, thousands of tons could be easily gleaned from the surface; and but a short distance below the surface are large beds, the extent of which has not yet been ascertained. This galena is never found free from silver, yielding from 10 to 500 ounces to the ton of metal.

"From some pieces of galena, fair average ore from a number of veins in Ten-Mile district, the following assays for silver were obtained by Dr. A. A. Hayes, State assayer, of Massachusetts:

	Ounces.	Pennyweights.	Grains.		
Pyramid vein	81	13	8	per ton	2,000 pounds.
Merrimac "	68	12	0	"	"
Polygon "	266	8	0	"	"
Hard Cash "	108	2	12	"	"
Blackstone "	85	18	6	"	"
Young "	65	6	16	"	"
Tinsley "	178	17	0	"	"
Siberian "	106	9	20	"	"
Augustine "	221	3	12	"	"

giving an average exceeding 130 ounces to the ton."[1]

ARIZONA AND NEW MEXICO.

The silver mining region of the Territory of Arizona joins upon the Mexican States of Sonora and Chihuahua, and is traversed by the same ranges of mountains that bear so many rich silver veins in these States and in Durango and Zacatecas. The old town of Tubac was formerly the centre of the mining region of Arizona, and it is supposed that within a distance of 15 miles from it each way there are probably 150 deserted silver mines or openings. One of the best known localities is the Arivaca rancho, and seven miles northeast is the Cerro Colorado, in which the Heintzelman mine is located. This mine was worked at intervals for some years under great disadvantages, and is said to have yielded $100,000 up to January, 1860. This, as well as the Santa Rita, the Patagonia, and other mines, were abandoned, in 1862, on account of the continued depredations of the Apache Indians, and work has not since been resumed.

In New Mexico there are important veins of argentiferous galena in the Organ mountains, about 15 miles from Camp Fillmore. Six different veins are described, all bearing argentiferous galena and copper ore. The average silver yield of the decomposed veinstone is about $70. Other samples assay from $20 to $500 per ton.

Ores similar to those of the Organ mountains occur in the San Dia mountains, near Albuquerque. There are silver-bearing veins, also, at Los Cerillos, 15 miles from Santa Fé. Silver veins and ores are reported in the San Juan mountains, and specimens of slag from ancient furnaces have been found near Fort Defiance.[2]

ATLANTIC PORTION OF THE UNITED STATES AND LAKE SUPERIOR.

No silver veins, properly so called, are found east of the Rocky mountain chain within the limits of the United States, but considerable quantities of silver have been extracted from argentiferous lead ores at different localities, and have been found with the copper of Lake Superior.

[1] Ibid., p. 50.

[2] For further details regarding these and other mines in New Mexico, see the volume on Silver Ores and Silver Mines, by the author; New Haven, 1861.

The most important mines of argentiferous lead ore are: the Silver Hill, or Washington mine, of North Carolina; the Wheatley mines of Phœnixville, Pennsylvania; the Middletown mine in Connecticut; the Northampton lead mines in Massachusetts, and the Lubec mines in Maine. Mines of argentiferous lead have also been worked in Wythe county, Virginia.

The Silver Hill mines in North Carolina were discovered about 1836, and were worked at intervals until 1852. The mine was then closed and was filled with water until about 1858, when it was reopened, but was again closed in 1861. Its production for 1844 is reported as $24,000 of silver, $7,253 of gold, and 160,000 pounds of lead. In 1851 it produced 56,896 pounds of lead and 7,942 ounces of auriferous silver, or an average of 11.2 ounces per ton of ore and 279 ounces per ton of lead. The ore is a mixture of argentiferous galena with zinc blende. Small quantities of silver glance have been observed by the writer, and an alloy of gold and silver of a pale yellow color like that of the Comstock lode.

The Wheatley mines of Pennsylvania are not now worked. The engine shaft is 300 feet deep, and the total length of drivage is over 400 feet. At the time of the suspension of operations there in 1854 the aggregate production had reached 1,800 tons. The galena ores yield from 70 to 80 per cent. of lead, and from 15 to 120 ounces of silver to the ton, or from 26 to 30 ounces on an average.

Lake Superior.—Large masses of native silver are found from time to time imbedded in the midst of the masses of native copper of Lake Superior, or are enclosed with it in the gangues. A variety of specimens was exhibited at the Exposition in connection with the display of Lake Superior copper. It is very singular that the two metals are perfectly joined so as to form homogeneous masses without any commingling or alloy. Specimens were shown that had been sawn into two parts, each of which was formed half of silver and half of copper.

It is impossible to ascertain the total production of silver from this source. Much of it was formerly stolen by the miners, and considerable amounts are reserved for specimens, or are worked up into table-ware without passing through any public channel. The following amounts from Lake Superior were deposited in the United States mint and branches for the years named:

1858	$15,623 00	1864	$8,765 77
1859	30,122 13	1865	13,671 51
1860	25,880 58	1866	22,913 96
1861	13,372 72	1867	18,555 35
1862	21,366 38		
1863	13,111 32	Total	$183,382 72

CHAPTER V.

THE SILVER REGIONS OF MEXICO, CENTRAL AMERICA, AND SOUTH AMERICA.

MEXICAN SILVER REGION—REAL DEL MONTE MINING COMPANY, AND GENERAL RESULTS OF ITS MINING OPERATIONS—DETAILS OF SILVER ORES REDUCED AND OF DIVIDENDS PAID—REPRESENTATION OF SILVER MINES OF CHILI AT PARIS—CHANARCILLO MINES—TRES PUNTAS—TOTAL SILVER PRODUCTION OF CHILI—PRODUCTION OF SILVER IN PERU AND BOLIVIA.

MEXICO.

It is to be regretted that the silver mines of this great silver-producing country were not represented in the Exhibition. In the year 1800 over 60 per cent. of the annual supply of silver to the world was drawn from Mexico, but the production has since greatly decreased.

Up to the time of the invasion of Mexico by Cortez, in 1519, silver does not appear to have been produced there in large quantities, though gold was very abundant. Thirty or forty years afterwards, silver mines were opened and worked at Tasco, Zultepeque, and Pachuca. In 1548 mines were worked in Zacatecas, and 10 years after in Guanaxuato. This was but the commencement of the great era of silver mining in Mexico, yet the annual yield at that time, according to an estimate by Humboldt, was not less than from $2,000,000 to $3,000,000.[1] It subsequently increased to $23,000,000 before the close of the 18th century. Between the years 1800 and 1810 the average coinage of gold and silver at the various mints in Mexico was $23,664,622; the ratio of the gold to the silver being, in value, as 0.05 to 1. During the war of independence the production was greatly lessened, and from 1810 to 1845 the average was not over $12,000,000 for silver and $100,000 for gold. Since that time the production has increased, and has been estimated by the best Mexican authorities at $23,000,000 in silver, and from $1,000,000 to $2,000,000 of gold annually. Mr. Phillips, in his recent work, says that the present annual produce of the mines cannot be much less than $26,000,000 in silver and $3,200,000 in gold. This estimate, however, appears to the writer to be much too high. It is well known that, during the civil commotion of the past four or five years, systematic mining has been neglected, and that the production in some sections has nearly ceased. In 1864 and 1865 many of the enterprising capitalists of California, stimulated by the great success of mining upon the Comstock lode, embarked in various silver mining enterprises in Chihuahua, Durango, and other States and districts accessible from the Pacific coast. Considerable quantities of silver and

---

[1] *Vide* Silver Ores and Silver Mines, &c., compiled by the author; New Haven, 1861.

silver ores were obtained; but in 1866–'67 most of these enterprises were abandoned. There are no very recent reliable statistics of the silver production in Mexico, but it is believed not to exceed $13,000,000 for 1867. The total produce of silver from the earliest period up to 1845 has been estimated by Chevalier at 162,858,700 pounds troy. Mr. Danson, in revising the statistics of the production of the precious metals in North and South America, gives the annexed tabular statements of the production from 1804 to 1846, inclusive.[1] This is made up from the mint returns, the reports of British consuls, and from Duport.

Production of gold and silver in Mexico from 1804 *to* 1846, *inclusive, (according to mint returns cited by Danson.)*

Period.	Silver.	Gold.	Yearly average.	
			Silver.	Gold.
In seven years, 1804 to 1810	$159,947,937	$9,161,767	$22,749,700	$1,311,[illegible]
In nineteen years, 1811 to 1829	191,331,930	9,187,044	10,070,100	[illegible]
In eleven years, 1830 to 1840	105,251,446	7,076,[illegible]	9,568,300	[illegible]
One year, 1841	12,781,747	756,056	....	....
In five years, 1842 to 1846	66,434,638	4,031,384	13,[illegible]	[illegible]
Total in forty-three years	535,047,698	30,238,545	....	....

To this total Mr. Danson adds an estimated production for 1847–'48 of silver, $26,573,800; gold, $30,232,545; and, adopting the estimates of Duport, that one-fifth of the total silver production, and five-eighths of the gold production, do not pass through the mints, he gives the following resumé of the total production of Mexico from 1804 to 1848, inclusive:

	Value of silver.	Value of gold.
Passing through the mints	$561,621,498	$31,845,065
Not passing the mints	140,405,374	53,075,140
	$702,026,872	$84,920,225

In the Statesman's Year Book for 1868, the present annual average production of the principal silver mining districts of Mexico is estimated as follows:

Zacatecas	$6,000,000
Guanajuato	2,000,000
San Luis Potosi	500,000
Guadalajara	600,000
Mexico	1,000,000
Durango	1,000,000
	$11,500,000
Bars and silver exported secretly, add	1,000,000
	$12,500,000

[1] *Vide* Journal Statistical Society of London, xiv.

The coinage of the mint has been as follows since 1856:

1857	$5,318,000	1863	$5,750,000
1858	5,215,000	1864	4,660,000
1859	5,485,000	1865	4,060,000
1860	5,785,000	1866	4,061,000
1861	5,384,000		
1862	4,660,000	Total	$50,378,000

Or an average of over $5,000,000 annually. The coinage for 1867 is estimated at about $4,000,000.[1]

REAL DEL MONTE MINING COMPANY.

The most recent statistics accessible upon the Mexican mines relate to the veins and works of the Real del Monte company, situated about 60 miles north of the city of Mexico. The total profits of these mines in the last 17 years has been over $12,000,000, and a large part of it has been divided between the shareholders and owners. These data were supplied to Mr. Phillips by Mr. Buchan, and, as they are of great practical interest, they are cited from the recent work of the former, page 284. There are now seven steam engines in operation for draining, with cylinders from 18 to 85 inches diameter. There are eight rotary engines for hoisting and driving machinery at the workshops, and 23 water-wheels at the different reduction works. The grinding or pulverizing machinery amounts to 350 stamp-heads and 74 arrastras, 24 driven by water-power and 50 by mules. There are 80 amalgamating barrels. The total number of cargas of ore reduced yearly is 312,000, of which 206,000 are treated by the barrel process and 106,000 by the patio process.

General results of mining operations by the Real del Monte company, in the districts of Real del Monte and Pachuca, in the year 1860.

General expenses of management	$50,170
Cost of draining the two districts	167,934
Cost of extracting ores from various mines	647,338
Cost of reducing ores in different haciendas	841,606
Duties on silver paid to the Mexican government	173,587
Freight of ores from mines to reduction works, including cost of repairing roads	186,503
Convoys of silver to the coast, or mint of Mexico	14,877
Agencies, commissions, &c	7,109
Total cost on current working of the mines	$2,089,124
Total produce, 277,396 cargas of ore, from which were extracted 423,394 marks of silver, value	3,710,891
Profit on current workings	$1,621,767

[1] Mexican Standard, November 11, 1867.

The above profit was applied as follows:

Reinvested in discovery works in different mines	$181,052
Reinvested in enlarging and improving works for the reduction of ores	73,120
Purchase of forests for fuel	31,000
Cost of maintaining a force of 150 cavalry and 50 infantry, necessary for the security of the districts during the civil war.	60,000
Paid as dues to part owners of mines	353,070
Paid as dividends to shareholders of the company	923,525
Total	$1,621,767

Table of stores consumed during the year 1860.

Timber from forests belonging to the company	$30,000	
Wood fuel	200,000	
Charcoal	60,000	
		$290,000
Salt	150,000	
Quicksilver	100,000	
Iron and steel	50,000	
		300,000
Barley and straw	100,000	
Tallow and oil	40,000	
Gunpowder	15,000	
Sulphate of copper	14,000	
Sacks and cordage	18,000	
Lime and bricks	10,000	
Litharge	13,000	
Leather and hides	15,000	
Sundry stores	45,000	
		270,000
Total		$860,000

Table showing the details of silver ores reduced by the Real del Monte company, in the districts of Real del Monte and Pachuca, from May, 1849, when the present company was first formed, to the end of the year 1865.

Years.	Ores reduced by smelting.		Ores reduced by barrel amalgamation.		Ores reduced by patio amalgamation.		Total each year.			Average per monton.[1]
	Ores.	Silver.	Ores.	Silver.	Ores.	Silver.	Ores reduced.	Silver produced.	Value of silver.	
	Cargas.	*Marks.*	*Cargas.*	*Marks.*	*Cargas.*	*Marks.*	*Cargas.*	*Marks.*		
1852	7,108	45,671	281,629	221,827	21,975	19,412	310,712	286,910	$2,508,655	$9 00
1853	2,903	15,358	141,208	131,518	37,040	29,063	181,151	175,939	1,537,796	9 71
1854	2,386	14,913	152,614	160,900	37,982	31,313	192,982	207,126	1,811,822	10 73
1855	2,690	23,612	181,353	217,193	38,010	46,868	222,053	287,673	2,375,503	12 90
1856	6,011	48,666	209,053	243,041	46,490	58,843	261,554	350,550	3,081,663	13 40
1857	4,926	44,942	219,326	238,041	50,400	63,183	274,652	346,166	3,039,019	12 50
1858	5,056	49,582	217,461	218,291	48,355	53,638	270,872	321,511	2,824,831	11 80
1859	4,813	52,057	226,775	283,112	44,013	51,434	275,601	386,603	3,404,459	14 00
1860	4,698	47,442	222,498	314,745	50,200	61,207	277,396	423,394	3,710,891	15 20
1861	4,162	42,397	212,480	263,990	63,947	87,545	280,589	393,932	3,782,399	15 70
1862	4,203	47,518	209,861	310,906	60,412	73,968	274,476	432,392	3,445,222	14 00
1863	3,543	32,983	194,097	217,204	76,920	88,370	274,560	338,557	2,984,351	12 30
1864	3,500	29,067	205,850	229,946	105,740	142,697	315,090	401,710	3,432,107	12 40
1865	1,921	19,273	170,600	186,535	97,642	144,055	270,163	349,863	3,044,572	13 00
Total	57,920	513,481	2,844,405	3,237,249	779,126	951,596	3,681,851	4,702,326	40,983,290	12 77

[1] The *monton* varies in the different mining districts, but in Real del Monte and Pachuca is 10 cargas, or 3,000 lbs. The mark of silver is 8 Spanish ounces, of 443.8 grains each.

Produce and profit of the silver mines worked by the Real del Monte Co
pany in the districts of Real del Monte and Pachuca, Mexico.

Four years to December—	Value of silver produced.	Profits paid—		Duties on silver to Mexican government.	Cost of dr ing mines
		As dues to part owners.	In dividends to shareholders.		
1852	$2, 508, 655	$155, 373	....	$101, 009	$215,
1853	1, 537, 796	152, 681	$256, 250	66, 015	69,
1854	1, 811, 822	199, 371	307, 500	82, 566	83,
1855	2, 375, 503	194, 511	461, 250	108, 604	86,
1856	3, 081, 663	276, 652	820, 000	140, 441	115,
1857	3, 039, 019	241, 553	461, 250	138, 375	107,
1858	2, 824, 831	233, 294	410, 000	130, 860	128,
1859	3, 404, 459	364, 858	666, 250	158, 939	120,
1860	3, 710, 891	448, 905	871, 250	173, 587	167,
1861	3, 782, 399	433, 963	820, 000	175, 359	156,
1862	3, 445, 222	341, 018	334, 500	159, 620	143,
1863	2, 984, 351	178, 936	557, 500	138, 466	174,
1864	3, 432, 107	279, 377	580, 000	159, 064	178,
1865	3, 044, 572	136, 815	....	141, 064	212,
Total	$40, 983, 290	$3, 637, 307	$6, 545, 750	$1, 874, 442	$1, 960,

Total dividends to shareholders of Real del Monte Company	$6, 545, 750
Paid as dues to part owners of mines	3, 637, 307
Duties to Mexican government	1, 874, 442
Total profit of the Real del Monte and Pachuca mines—17 years	$12, 057, 499

NOTHERN MEXICO AND SONORA.

Valuable observations upon the silver mines of northern Mexico an Sonora will be found in an article by the late Mr. Rémond, a geologi and mineralogist, published in the proceedings of the Academy of Natur Sciences, of California, vol. iii, pp. 245–258. An important tabul statement of details concerning some of these mines, given by M Rémond, is appended.

"The name of the 'Sierra Madre' is usually applied to the main rang of mountains of this country, or the western border of the plateau whic stretches north through the Territories of the United States, formin what may be called the great orographical feature of the continent. I northwestern Mexico this crumpled border of the great plateau compris an extensive mountainous region, by no means forming a continuous si gle chain, but rather several central ranges, with associated groups o parallel ridges, all having the same general course, which is approxi mately north-northwest and south-southeast. As the breadth of th chain widens as we go towards the north, so, too, that of the valley increases in that direction, the whole system of mountains and valley spreading out in something like a fan-shape.

"Going north, the chain appears to sink gradually, although determi nations of altitude in northern Mexico are extremely few in number. I is certain that there is, in about latitude 32°, a depression of the moun tain ranges which extends entirely across the continent, and which woul

enable the traveller to cross from the Atlantic to the Pacific, without necessarily surmounting any elevation greater than 4,000 feet.[1] The southeastern range is the highest, and the culminating point is said to be the Cerro de Cuiteco, 60 leagues northeast of Jesus Maria, on the western borders of Chihuahua. The approximate altitude of the Cumbre de Basascachic is 7,429 feet, and that of Guadalupe y Calvo 7,825 feet. To the north, the ranges east of Sahuaripa are also very high; but they have never been measured. No peaks or ridges, however, in this portion of Mexico attain anything like the elevation of the higher portion of the Sierra Nevada, few if any points exceeding 10,000 feet in altitude.

"The direction of the sierra is nearly that of a line connecting some of the best mining districts in Mexico, which are situated on or very near the summit of the mountains. These districts are the following, enumerating them in their geographical order from the south towards the north; in Durango, San Antonio de las Ventanas, Guarisamey, and San Dimas, remarkable for their auriferous silver ores, and 62 Mexican leagues northeast of Mazatlan; in Chihuahua, Guadalupe y Calvo, and San Pedro de Batopilas, yielding fine specimens of native silver; also, Jesus Maria, in the same state, and the Real del la Cieneguita, Sonora, with silver and gold mines.

"GENERAL GEOLOGY.—The geological structure of the occidental slope of the Sierra Madre, as well as that of other parts of this great chain, is exceedingly interesting, and, as yet but very little known, notwithstanding the valuable investigations of Humboldt and other eminent men; for, up to the present time, the age of the different formations has never been fixed with any degree of accuracy, from want of materials and of sufficient observations. In 1863, 1864, and 1865, however, I explored quite a number of localities in northwestern Mexico, and was thus enabled to obtain a pretty good general idea of the geology of that region; and, in Sonora, to which my attention was especially devoted, I succeeded in finding fossils in sufficient quantity to allow of the determination of the age of the principal formations of the northern Sierra Madre.

"The igneous rocks, which occur more abundantly on the Pacific slope, are granites, either fine or very coarse-grained; porphyries, more or less feldspathic; and greenstones, all of which are cut by numerous dikes of extremely varied character. The granites, however, are very poor in veins of the precious metals, while the porphyries are highly metalliferous. In Sinaloa (Candelero) and Durango (San Dimas) we see that the granites underlie the metalliferous porphyries, and that the greenstones, in Sonora, (near Hermosillo and in the vicinity of La Haciendita,) penetrate through them.

"The oldest sedimentary rocks which I have observed belong to the Carboniferous series; this is represented in the eastern part of Sonora by heavy masses of limestone, forming very high and rugged ridges, running a little west of north. The upturned strata are seen in many places to rest on granite. Argentiferous veins occur throughout this formation.

[1] See Emory, in Mexican Boundary Report, vol. i, p. 41.

"The next group of sedimentary rocks in order is the Triassic; this forms isolated mountain groups in Sonora, and offers an interesting field for investigation. Instead of limestones, it is made up of heavy beds of quartzites and conglomerates, with coal-bearing clay shales; all of these are disturbed and elevated, and rest on greenstones, feldspathic porphyries, or granite. Wherever metamorphosed, the Triassic rocks are auriferous and contain veins of silver ores. The metamorphic slates and limestones of the Altar and Magdalena districts, which include the richest gold placers of Sonora, may possibly be of Triassic age; but the fossils collected are too imperfect to admit of this being determined. There are some reasons for believing those rocks to be rather of Jurassic than of Triassic age, as they differ in lithological characters from both the Triassic and Carboniferous of northern Mexico, resembling rather the Jurassic gold-bearing slates of the Sierra Nevada, in California; besides, they lie outside and to the west of the Sierra Madre. It may also be noticed that the gold which they furnish does not resemble that obtained from the Triassic strata. The Cretaceous period is also represented at the foot of the Sierra Madre, at Arivechi, in Sonora.

"MINES.—The richest and widest veins are those northeast of Mazatlan, near San Dimas, Guarisamey, &c., in Durango. These veins cut all the rocks older than the Cretaceous, whether igneous or sedimentary. The mines of Sinaloa are richer than those of Sonora. In the former state the ore-bearing portion of the veins is from a few feet to several yards in width; in the latter, generally from one to two feet. In Durango and Sinaloa, gold, native silver, and sulphuret of silver occur, associated with galena, yellow blende, and iron pyrites. In Sonora the principal ores are argentiferous gray copper, with galena, black blende, copper pyrites, arsenical pyrites, carbonate of lead, ruby silver, arsenical silver, and gold. Each mining district is characterized by a peculiar system of veins; in all as many as twenty different systems have been observed. The most abundant vein stones are quartz, either chalcedonic, crystalline, or massive; brown spar; heavy spar; oxide of iron. The veins occurring in the metamorphic Triassic rocks are usually parallel with the stratification, so that they lie nearly horizontal where the formation has been but little disturbed. As to the yield of the silver ores, it varies extremely, and it would be necessary to enter into a full description of all the different districts to give an idea of it. It may be noticed, however, that the arsenical pyrites, which is auriferous in the Sierra Nevada, becomes argentiferous in the Sierra Madre. The veins vary in their direction from a little east to a little west of north; the richest ores near San Dimas run northeast and southwest. There are but few rich mines in Sonora, a state of which the mineral wealth has been much exaggerated. There are, however, some deposits of variegated copper, and veins of magnetic and specular iron.

"The annexed tabular statement will give the principal facts obtained with regard to the mines examined in northern Mexico:

Tabular statement showing the position and character of the principal mines of Northern Mexico, from 1863 to 1865.

Mines.	Location.	Country.	Strike.	Dip.	Width.	Matrix.	Ores.	Yield, per ton.
Naghuila	Near San Javier	Labrador porphyry	N. 35° W.	50° NE	1½ foot	Crystalline quartz	Sulphates of zinc, lead, iron, arsenical, and copper pyrites; ruby silver and native silver.	1st class, $1,200; 2d class, $125.
Eureka	Between S. Miguelito and Los Bronces.	Greenstone	N. 45° W.	35° to 40° NE		Quartz	Mispickel, blende, galena	
Pleiteada	Near San Javier	Labrador porphyry	N. 30° W.	45° NE	1½ foot	do		
San Juan	do	Quartzite, (Triassic)	N. 65° E.	50° S.SE	4 feet	Quartz and iron ore	Galena, zinc, carbonate of lead, iron pyrites.	
Ceballos	Near Los Bronces	Labrador porphyry	N. 25° E.	85° S.SE	2 feet	Magnetic iron		
Higuera	do	Greenstone	N. 5° E.	80° East	2½ feet	do	Copper pyrites and gray copper ore.	
La Blanca	Near San Antonio de la Huerta.	Quartzite and conglom'e, (Triassic.)	N. and S.	15° East		Vesicular quartz	Gold and chloro-bromide of silver	$43
San Luis	do	Quartzite, (Triassic)	N. 40° W.	35° NE	1½ foot	Decomp. quartz and sulphate of baryta.	Blende, galena, mispickel, sulphuret of iron, and native silver.	1st class, $787; 2d class, $125.
Santa Barbara	Near Corral Viejo	Quartzite	NE. to SW.	30° SE	1½ foot	Quartz	Galena, carbonate of lead, iron pyrites, and gold.	$67 75
La Sierra	Near San Javier	Labrador porphyry	N. 60° E.	80° N.NW	3 feet	Magnetic iron	Gray copper and iron pyrites	
San José	Near Los Bronces	do	N. 27° E.		1½ foot	Sulphate of baryta	Magnetic iron and iron pyrites	
El Secorro	do	do	N. 25° E.					
Zaragoza	do	do	N. 23° E.			Magnetic iron		
San Luis Gonzaga	Near San Javier	do	N. 30° W.	30° to 40° NE	8 inches	White quartz	Galena, blende, mispickel, and iron pyrites.	
La Colorado	Near Los Bronces	Altered sandstone and slate, (Triassic.)	N. 50° E.	80° South	5 feet	Iron ore and quartz		
Aguajito	Near San Javier	Labrador porphyry	N. 24° E.			Magnetic iron		
Santa Edubigen	La Barranca	Quartzite, (Triassic)	NE. to SW.	30° NW	2½ feet	Quartz		
La Cuadra	Near San Javier	Labrador porphyry	N. 10° W.	20° to 25° E.	1 foot	do	Arsenical pyrites, blende, and galena.	
El Rosario	do	do	N. 10° W.	20° to 25° E.		Crystalline quartz		
El Escritorio	do	do	NW. to SE.	NE	1½ foot	White quartz		
Santa Rosa	Between Los Bronces and San Javier.	Quartzite, (Triassic)	N. 10° E.	55° South	3 feet	Quartz and iron ore	Carbonate of lead, iron ore, galena, blende, and iron pyrites.	
Soledad	Candelero	Porphyry, (metam.)	N. 55° E.	85° SE	30 feet	Quartz		$866 65
Carmen	do	do	N. 85° E.	85° North	28 feet	do	Silver and gold, sulphuret of silver	186 65

Tabular statement showing the position and character of the principal mines of Northern Mexico, &c.—Continued.

Mines.	Location.	Country.	Strike.	Dip.	Width.	Matrix.	Ores.	Yield, per ton.
Atocha	Candelero	Porphyry, (metom.)	N. 45° E.	85° North	14 feet	Quartz	Silver and gold, sulphuret of silver.	$213 35
Rosario	do	do	N. 50° E.	70° to 80° NW.	17 feet		do	160 00
Contrestaca	Near La Puerta	Metamorphic rocks	N. 63° E.	76° NW		White quartz	Blende, galena, sulphuret of silver	
Descubridora	do	do	N. 35° E.	69° NW		do	do	
Soledad	Between La Puerta and San Dimas.	do	N. 65° E.	Perp		do	do	
Candelaria	Near San Dimas	Porphyry, (metam)	N. 63° E.	63° N.NW		White quartz		1st class, $3,210; 2d class, $133.
Bolanos	do	do	N. 45° E.	75° SE	20 feet	do	Galena, blende, gold	
Cinco De Mayo	Near Zaragoza	Sienitic granite	N. 52° E.	75° NW	4 feet	do	Galena, blende, iron pyrites, brittle silver glance, native silver.	1st class, $800; 2d class, $180.
Cinco Señores	Near Copála	Greenstone	N. 20° W.	45° E.NE	1 to 4 feet.	Quartz	Galena, blende, iron pyrites	
Napoleon	do	do	N. 10° W.	80° E	2 to 8 feet.	Chalcedonic quartz	Galena, blende, copper pyrites, &c.	
Rosario	do	do	N. 50° W.	85° E		do		
Piatino	do	do	N. 22° W.	Perp	4 feet	do	G[illegible]a, blende, copper pyrites	
Haval	A few leagues from Mazatlan.	Sienitic granite	N. 80° E.	80° N		Quartz	Oxide of lead, native silver	
Mina Grande	Near San Marcial	Metamorphic slates, (triassic.)	N. and S.	30° W.	2 feet	do	Sulphuret of antimony, mispickel, copper pyrites, blende, iron pyrites.	
Las Cruzecitas	do	do	N. 15° E.	65° E.	4½ feet	Heavy spar	Tepustete with copper and iron pyrites, and gray copper ore.	1st class, $90 to $100; 2d class, $35 to $40.
Guijosita Vieja	Near San Javier	Labrador porphyry				Quartz	Galena, arsenical pyrites, blende, copper pyrites.	
La Antimonia	do	do				Crystalline quartz	Sulphuret of antimony and lead	
Dios Padre	Trinidad	do			9 to 12 feet of ore.		Gray copper ore, galena, iron pyrites, native silver.	
Agua Grande	Nine miles from San Marcial.	Porphyry, (volcanic)	N. 38° to 40° E.	80° NW	1¼ foot	White quartz	Indigo copper, chrysocolla, chalkosine, chalcopyrite.	
La Colorado	Near Copála	Greenstone	N. and S.	20° W	40 feet	Chalcedonic quartz		
A[illegible]	Near San Marcial	Metamorphic slates, (triassic.)	do	30° W	8 inches	Rotten quartz and iron ore.	Chlorobromide of silver	

Los Bronces	Los Bronces	Greenstone	E. of N.	85° E.		Heavy spar	Magnetic iron, gray copper, copper and iron pyrites.	1st class, $350; 2d class, $40 to $60.
La Prieta	do	do	N. 40° E.	80° NW		do	do	
Alta Gracia	Near San Antonio de la Huerta.	Quartzite, (triassic)	N. and S.	30° E.	4 feet	Brown spar	Copper pyrites and gray copper	
Rosario de Guadalupe.	San Javier	Greenstone	N. 70° E.	60° S.SE	2 feet	Quartz	Black blende, iron pyrites, and galena.	
Aurora	Near Los Bronces	do	N. 10° E.	45° to 50° E.	2 feet	Magnetic iron	Gray copper ore and copper pyrites	
El Taste	Near San Javier	do	N. 15° E.	50° to 55° E.	5 feet	Quartz	Galena, blende, copper and iron pyrites, (*petanque*.)	$100.
Providencia	Near Tecoripa	Quartzite, (triassic)	N. 10° E.	65° E.	1 ft. 2 in.	do		1st class, $200; 2d class, $35 to $40.
La Bojorqueña	do	do	N. 20° E.	65° E.		Quartz, (ferruginous.)	Black blende, iron pyrites, galena, copper pyrites.	
La Chiploñena	Near Topisco	Granite						
Mina Prieta	Near San Antonio de la Huerta.	Quartzite, (triassic)				Brown spar	Copper pyrites, gray copper	
El Tesoro	Cacahhilas	Granite	NW. to SE.	75° SW	4 feet			1st class, $290; 2d class, $90.
Rosario	Cañada de la Iglesia, near San Antonio.	Quartzite, (triassic)	NE. to SW.	85° NW	2 feet		Galena and blende	$60 00
Babicanora		Limestone, (carboniferous.)	NE. to SW.	75° NW	5 feet	Quartz	Galena, iron pyrites, fahlerz, ruby silver ore; gold and silver.	$34 65

CHILI.

The silver regions of Chili were represented by a large and brilliant collection of the ores forwarded by the government commission at Santiago, and accompanied by a catalogue and explanatory notes upon the mineral wealth of Chili, by M. Domeyko, inspector general of the mines of Chili, and first professor in the School of Mines at Santiago. These notes were published in French, in connection with the statistical notices by the commission.[1] The following data are translated and condensed from those of M. Domeyko.

The principal branches of mining industry in Chili are: 1. The production of copper; 2. The production of silver; 3. The production of gold, cobalt, and nickel; 4. The production of coal.

The most important and profitable of all is the production of copper. This is exported chiefly in the ore, or reduced to a matt or regulus, much of which contains silver.

The value of the annual silver production of Chili is about $2,000,000. The most important and productive mines are in the department of Copiapo. In this department the silver-bearing formation, with the exception of some veins of argentiferous copper ore in the central Andes, is an argillaceous limestone of the Jurassic epoch, and the veins or deposits are usually found near the junction or contact of this formation with the eruptive rocks. The principal mines, and which have furnished nearly all the silver for exportation and for coinage at the Santiago mint, are those of Chanarcillo and Tres Puntas.

Chanarcillo.—The discovery and opening of these mines dates from 1831, and a description of them was given for the first time by M. Domeyko, in 1846. Since that time the field of mining has been considerably enlarged. Some of the principal mines are the Valenciana, Colorado,[2] and St. Francisco el Delivio. There are in all some 85 or 86 mines belonging to different proprietors, but very few of them are worked with profit. A railway now connects these mines with the port of Caldera, and thus, by affording cheap and rapid transportation, the proprietors are enabled to work ores which do not contain more than 1.001 to 0.0015 of silver.

These mines are remarkable for their production of the ore known as horn silver (chloro-bromide) in great quantities and in large masses. The principal varieties of ores now found are native silver, horn silver, and ruby silver. Some fragments of polybasite and of galena are found from time to time, but in general these and pyrites, blende, and sulphuret of copper are very rare.

A very good description of these mines is also given by Dorsey.[3] In

[1] Notice Statistisque sur le Chili et Catalogue des Mineraux Envoyés, á l'Exposition Universelle de 1867; 8vo.; Paris, 1867. Circulated at the Exposition.

[2] Annales des mines, 1846.

[3] Mining Magazine and Journal of Geology, &c., I, 102. See also "Silver Ores and Silver Mines," p. 59.

1859, 78 mines were worked, 1,200 men were employed, and the production was 8,000 pounds of pure silver monthly. From the date of their discovery in 1832 to 1859, the total production was valued at $60,000,000, nineteen-twentieths of which came from 25 mines.

The collection at the Exposition contained a variety of specimens from the Chanarcillo mines, Valenciana, Dolores, and Loreto. These were chiefly native silver and the chloro-bromide, with some specimens associated with native arsenic. Nos. 186 to 207 were interesting specimens of red silver ores, of different varieties and forms. No. 209 was a mass of pure chloro-bromide from a vein nearly an inch wide, without any gangue in the mine Descubridora. The whole series was accompanied by a suite of the rocks which are traversed by the silver-bearing veins. One specimen contained an *ammonite* taken from the Loreto mine.

Tres Puntas mines.—These mines were discovered later than those of Chanarcillo, and have been about 20 years under exploitation. They are situated northeast of Copiapo, further from the coast than those of Chanarcillo, but in the midst of a formation which appears to be of the same age and has a similar mineral composition. The district has also a much greater extent, and in the centre of it there is a mass of eruptive diorite which is not seen at Chanarcillo.

The chief difference between the mines of the two districts is that at Chanarcillo; the mines have produced and are still yielding large masses of chloro-bromide of silver and iodide of silver, which, in depth, pass into red silver and arsenical ores, while at Tres Puntas the mines have not yielded chloridized ores, except at the outcrops of the veins, but instead, they have given immense quantities of amorphous antimonial, and arsenical red silver ores, mixed with sulphuret of silver, with polybasite, arsenical cobalt, and, above all, native silver disseminated in the midst of the gangues.

The richest and most important of the Tres Puntas mines is called the Buena Esperanza, and it was represented by ten cases of specimens selected and arranged by Mr. Plisson, the engineer and director of the works. This collection contained, besides the product of the Buena Esperanza, some choice mineralogical rarities from other localities, such as large crystals, and groups of crystals, of light ruby silver from Chanarcillo, masses of native arsenic, native amalgam, miargyrite from the mine Alfinhallada; and a new species, a double iodide of silver and of mercury, called tocornalite.

The mines of the district of Aconcagua were also represented in the collection, as well as several other districts and mines of minor importance.

There was also an interesting metallurgical collection, showing silver ores and their products in the various stages of mechanical preparation and of treatment for the extraction of the silver and other metals. One series illustrated the process of amalgamation followed in the establishment of Messrs. Ossa & Escobar, directed by Kronnke. This process is said to have received the special protection of the Chilian government by a patent, and to remain a secret.

Another series contained specimens of the products of the smelting establishment of Nantoco, a few leagues distant from Copiapo. At this place silver ores, and copper ores containing silver, are concentrated into matts, which are then exported, chiefly to England, for further treatment and the separation of the metals. Following is a list of the specimens of the series, with their percentages of copper and of silver:

Percentage value of the matts in copper and silver.

Locality of ore.	Per cent. of copper.	Per cent. of silver.
Garin Viejo	0.025	0.0025
Cerro-Blanco Locabon	0.300	0.0012
Cerro-Tajo	26.000	0.0066
Nantuco-Brillador	0.160	....
Cerro-Blanco de la Sevenne	0 0250	0.0040
Ponta de Cobre Bateas	0.3000	....
Checo de la Dolores	0.5700	....
Algarovito	0.3400	0.0008
Pintados de Farolo	0.1500	....
Bandurrias	0.3000	0.0014

It is customary to add to these ores the poor residues from the amalgamation works. The mixture gives matts, which contain 56 per cent. of copper, and 0.0241 of silver. The scorias usually retain 0.002 of copper, and 0.0005 of silver.

TOTAL SILVER PRODUCTION OF CHILI.

Humboldt estimated that the annual yield of silver in Chili at the beginning of this century was only 18,300 pounds troy. The total yield up to 1810 was estimated by Chevalier at 804,000 pounds troy; and from 1804 to 1845 at 1,803,636 pounds. The product in Copiapo from 1830 to 1853 amounted to 3,362,184 marks, or about $30,000,000.[1] The following tabular statements[2] of the metals and ores exported from Chili, and of the money coined from 1841 to 1858, with the exception of the years 1850 and 1853, for which there are no returns, show a total production of silver for 16 years of $46,826,998, or an average of nearly $3,000,000 per annum.

The statistics presented at the Exposition show that the exports of silver for five years (probably from 1860 to 1865) were 165,432 kilograms, about 5,321,396 ounces troy, or a mean of 33,086 kilograms a year, (1,064,266 ounces.) This does not show the total production of the country, for there should be added to these figures the value of the silver contained in the matts and in the rough ores exported, valued, in 1865, at $626,629; also the silver coinage at the Santiago mint, which, in 1865, amounted to $450,644, and in 1866 to $973,428, making the total value of the production for 1866 about $3,000,000.

[1] Mining Magazine, first series, iii, 38.

[2] Obtained from official sources in 1860, through Lieutenant J. M. Gillis, for the writer.

Metals exported from Chili and money coined at the mint in Santiago, Chili, from the year 1841 to 1849.

Year.	Gold at $2 50 per castellano, or 1-50th of a mark.				Silver at $10 per mark of 8 ounces Spanish.			
	Exported.		Coined.		Exported.		Coined.	
	Quantity.	Amount.	Quantity.	Amount.	Quantity.	Amount.	Quantity.	Amount.
	Castellanos.		*Castellanos.*		*Marks.*		*Marks.*	
1841	48, 110	$120, 275	163, 237	$408, 093	140, 123	$1, 401, 230	229	$2, 290
1842	124, 800	312, 000	130, 787	326, 967	148, 283	1, 482, 830	279	2, 790
1843	16, 510	41, 275	154, 325	385, 813	115, 688	1, 156, 880	5, 783	57, 830
1844	32, 010	80, 025	169, 756	424, 390	116, 278	1, 162, 780	21, 003	210, 030
1845	88, 150	220, 375	132, 987	332, 467	175, 052	1, 750, 520	15, 432	154, 320
1846	80, 710	210, 775	96, 962	242, 405	176, 112	1, 761, 120	11, 672	116, 720
1847	112, 205	280, 512	114, 550	286, 375	176, 285	1, 762, 850	5, 844	58, 440
1848	118, 576	296, 440	83, 887	209, 718	214, 993	2, 149, 930	7, 895	78, 950
1849	105, 228	263, 070	312, 188	780, 470	309, 373	3, 093, 730	13, 635	136, 350
Total	726, 299	1, 815, 747	1, 358, 679	3, 396, 698	1, 572, 187	15, 721, 870	81, 772	817, 720

Year.	Copper per quintal of 100 pounds Spanish.						Total amount.			
	In bars, at $14 per quintal.		Ore, at $2 50 per quintal.		Regulus, at $4 50 p. quin.		Gold.	Silver.	Copper.	Total.
	Quantity.	Amount.	Quantity.	Amount.	Quantity.	Amount.				
	Quintals.		*Quintals.*		*Quintals.*					
1841	95, 331	$1, 334, 634	258, 219	$645, 547	*	*	$528, 368	$1, 403, 520	$1, 980, 181	$3, 912, 069
1842	76, 437	1, 070, 118	367, 964	919, 910	*	*	638, 967	1, 485, 620	1, 990, 028	4, 114, 615
1843	73, 893	1, 034, 572	426, 473	1, 066, 182	*	*	427, 088	1, 214, 710	2, 100, 754	3, 742, 552
1844	88, 225	1, 235, 150	328, 376	820, 941	110, 541	$497, 435	504, 415	1, 372, 810	2, 553, 326	4, 430, 752
1845	100, 944	1, 413, 216	284, 562	711, 405	92, 784	417, 528	552, 842	1, 904. 840	2, 542, 149	4, 999, 831
1846	130, 576	1, 828, 064	214, 474	536, 185	103, 116	464, 022	444, 180	1, 877, 840	2, 828, 271	5, 150, 291
1847	140, 893	1, 972, 502	94, 577	236, 441	86, 202	387, 909	566, 887	1, 821, 290	2, 596, 853	4, 985, 030
1848	150, 445	2, 106, 230	99, 189	247, 973	84, 977	382, 396	506, 158	2, 228, 880	2, 736, 599	5, 471, 637
1849	178, 716	2, 502, 024	76, 884	192, 210	59, 368	267, 156	1, 043, 540	3, 230, 080	2, 961, 390	7, 235, 010
Total	1, 035, 465	14, 496, 510	2, 150, 718	5, 376, 795	536, 988	2, 416, 446	5, 212, 445	16, 539, 590	22, 289, 751	44, 041, 786

* The export of regulus for the years 1841, 1842, and 1843 is excluded on account of non-existence of the statistical reports for those years.

Metals exported from Chili during the years 1851, 1852, 1854, 1855, 1856, 1857, *and* 1858.[1]

Year.	Gold.		Silver.		Silver ore.		Copper.						Total.
	Quantity.	Amount.	Quantity.	Amount.	Quantity.	Amount.	In bars.		Ore.		Regulus.		
	Castellan.		*Marks.*		*Quintals.*		*Quintals.*		*Quintals.*		*Quintals.*		
1851	119, 901	$299, 753	248, 375	$8, 277, 319	41, 487	$269, 418	128, 729	$1, 749, 780	60, 336	$106, 195	65, 906	$216, 539	$10, 919, 004
1852[2]	....	....	372, 302	3, 511, 553	104, 516	497, 843	211, 515	2, 736, 951	257, 157	415, 429	145, 112	473, 490	7, 635, 266
1854	....	....	301, 577	2, 714, 193	159, 591	1, 434, 425	171, 989	2, 772, 364	445, 042	881, 983	144, 216	662, 269	8, 465, 234
1855	....	....	270, 984	2, 648, 746	265, 672	1, 697, 449	177, 765	2, 909, 916	563, 908	1, 330, 584	257, 852	1, 729, 793	10, 316, 488
1856	....	....	246, 620	2, 589, 563	151, 113	1, 390, 200	139, 543	3, 000, 173	630, 180	1, 840, 352	366, 076	3, 314, 179	12, 134, 467
1857	....	....	....	1, 583, 234	....	1, 524, 982	....	3, 008, 610	....	1, 953, 326	....	4, 592, 134	12, 662, 286
1858	....	....	....	1, 248, 666	....	899, 817	....	3, 922, 003	....	2, 712, 971	....	2, 759, 785	11, 543, 242
Total	....	299, 753	....	22, 573, 274	....	7, 714, 134	....	20, 099, 797	....	9, 240, 840	....	13, 748, 189	73, 675, 987

[1] No returns for 1850 and 1853, nor for 1859 and 1860.

[2] For the years 1852, 1854, 1855, 1856, 1857, and 1858 no standard price was given per castellano, mark, or quintal.

PERU.

The most celebrated mines in Peru are those of Cerro de Pasco, at an elevation of 13,673 feet above the sea. There are two very remarkable veins which intersect directly under the market place of the city. The first vein, Veta Colquirirca, trends north and south, has been traced 9,600 feet, and is 412 feet wide in some places. The second vein, Veta Pariarirca, has a southeasterly and northwesterly course, has been traced for 6,400 feet, and is 380 feet wide in some places. The production of silver from these veins has been enormous, but has fluctuated greatly. In 1784, 68,208 marks of silver were produced, and in 1785, 73,455 marks. From 1784 to 1820, 1826 and 1827, the amount of silver produced was 8,051,409 marks, or nearly 59,000,000 ounces. During 17 years the production was under 200,000 marks, and above 300,000 only during three years.[1]

Besides the Cerro de Pasco mines, which are not inferior to those of Potosi, there are other rich mining districts in Peru. Von Tschudi enumerates the provinces of Pataz, Huamanchuco, Caxamarca and Hualgayoc. The celebrated silver veins of San Fernando, which were discovered in 1771, are situated in Hualgayoc. Rich mines were formerly worked at Huantaxaya, near Iquique, but they were soon exhausted. The silver mines of Castro Virreyna, in the Cordillera south of Huancavelica, have been explored to a considerable extent. Of 30 mines only seven were worked in 1851. One steam engine was employed.

The following description of the Cerro Pasco mines is condensed from the report of Lieutenant Herndon.[2] After the discovery by the Indians in 1630, these mines were worked without drainage, and with but little success until 1780, when the *socabon* or drain, or adit of San Judas was commenced. This adit is 5½ feet wide and 6 feet 10 inches high, and delivers the water from the mines into the lake of San Judas. It is about 3,500 feet long; was finished in 1800, and cost $100,000.

In 1806 another adit was commenced 88 feet lower than the San Judas, and it was not completed at the time of Herndon's visit. It is 6 feet 10 inches wide, and 8 feet 3 inches high. A part is in solid masonry, well arched, and a large quantity of water flows through it. This *socabon* is known as the *Quiulacocha*. In 1816 a contract was made by the *gremio* for the drainage of the mines by steam machinery. Three steam engines and pumps were erected and worked successfully until the war of independence stopped operations.

In 1825 the drainage of these mines was undertaken by an English company called the "Pasco Peruvian." The compensation to this company was to be in ores from the mine. After driving 110 feet in the adit, at a cost of $40,000, (between September 1825 and January 1827,) this company failed, and the government of Peru undertook the work by paying $2,000 a month towards the expenses. The mines also contrib.

[1] Condensed from Travels of Von Tschudi.

[2] Herndon and Gibbons's Exploration of the Valley of the Amazon, Part I, p. 108.

uted 12½ cents upon each mark of silver. The work was placed under the charge of Rivero, and he extended the adit 122 feet. The miners furnished the powder and candles, and the superintendent supplied the tools. It was stated officially that it cost $86 dollars to excavate one vara. It was at that time 8,250 feet long, about 350 feet below the surface, and cost abont $1,000,000. Steam pumping engines were again resorted to, and in 1851 two were in operation, a third was erecting, and a fourth had just arrived from England. The contract required the erection of four sets of engines, each to consist of two engines of 15 horse-power each, and to drive three pumps in such a manner that if any accident should happen to one engine the other would drive two of the pumps. These pumps were worked by chains and long copper rods. All the metal work was of copper. The acid water of the mine attacked and rusted iron very rapidly. It is said by Phillips that steam-power was first introduced into these mines in 1814 by Richard Trevithick, but the acid waters quickly destroyed the pumps, and in 1832 only one remained at work.

The ores are soft and were obtained in large quantities near the surface; the hill of Santa Catalina was completely honey-combed by the pits and galleries. These ores are known among the mines as *cascajos*; they do not require roasting, and they are worked in patio, or the "*circo*," requiring from 40 to 50 days. The general yield of these ores is six marks[1] to the *cajon* and their cost at the surface is from $6 to $16, according to their hardness and distance from the mouth of the mine. Following are statements of the expenses of raising and working.

Patio of 6 cajones at, $16 per caxon	$96 00
Transportation of 150 mule loads to the hacienda, at 25 cents	37 50
Grinding, at $10 per ca on	60 00
Magistral, calcined iron pyrites, 1 arroba	1 00
Salt, 40 arrobas, at 50 cents	20 00
Trampling by horses, at $5	25 00
Working and washing amalgam	11 50
Quicksilver lost, 35 pounds, at $1	35 00
Retorting the amalgam	6 00
	$292 00
Yield, 36 marks of silver, at $8 50	306 00
Profit	$14 00

This is a very small return, but it is observed that the ore rarely costs $16, and often gives seven or eight marks to the cajon instead of six, as calculated above.

The *pina*, or retorted amalgam, is put into bars of 125 pounds each at the government smelting house at the mines. All the produce of the mines must be melted there and stamped. The bars are marked with

[1] The *mark* = 0.507090 pound of 7,000 grains, and is worth about $8.60.

the number of the bar for the year, the number of marks it contains, the initials of the owner, and the figures 11.22, indicating the *ley* or quality. Remittances are made every week, and the expenses upon the silver before it is placed on board ship for exportation are thus enumerated:

Cost of a mark of *pina* in the mountains	\$8 50
Impost for steam pumping engines	25
Public works	.6¼
Government or export duty	50
Mineral tribunal duty	12½
Loss in running into bars	12½
Carriage to Lima, and other petty expenses	6¼
Profit to purchaser at the mines	37½
	\$10 12½

Twelve pennyweights is the standard of pure silver in the mint at Lima. The bars are assayed, and if up to the standard are worth \$8.6746 the mark; for every grain below 11.22 a deduction of .0303 of a dollar is made.

The remittances in silver bars, in April, 1851, varied from 4,500 to 7,500 marks weekly. The annual yield was about \$2,000,000 in value. Lieutenant Herndon cites a calculation of M. Castelnau, by which it appears that the total yield of the mines since their discovery in 1630, to the year 1849, was about \$475,000,000.

The total production of the Peruvian mines for 45 years, from 1804 to 1848, is estimated by Mr. Danson[1] as \$216,485,527 in value. He adds 25 per cent. to the official returns to cover the production of various districts not enumerated. His estimates are as follow:

Apparently passed under official inspection	\$146, 853, 494
Probably smuggled from the district of Pasco	19, 053, 005
Production of other districts whence no returns have been obtained	32, 918, 660
Probably raised in districts whence no accurate data can be obtained, add ¼ of \$146,853,494	36, 715, 498
Total, silver	\$216, 485, 527

For gold he estimates that the official records show only ⅜ of what is raised. The returns being \$11,837,587 for 45 years, he adds \$19,729,311, making an estimated total product of \$31,566,898 in value. It is believed that these estimates are too high, too great an allowance being made for the amounts unofficially exported, and for obscure districts.

The present total annual production of the Peruvian mines is estimated by Phillips at 299,000 pounds troy, the value of which would be about \$3,000,000.

[1] Journal of the Statistical Society of London, xiv, 32.

BOLIVIA.

The mines of Potosi were discovered in 1545, and have furnished an amount of silver which Humboldt estimated at £230,000,000, or about $1,150,000,000.

The average annual yield from the discovery to 1556 was about $11,600,000. At the end of the 17th century the production had declined to between three and four millions per annum. Chevalier, in 1845, estimated the annual production at from 48,000 to 60,000 pounds troy. In 1860 the annual yield was estimated at about $800,000. Chevalier estimates the total production of the Peruvian and Bolivian mines up to 1845 at 12,925,000,000 francs, or 155,839,180 pounds troy.

The total production of silver in Bolivia, from 1827–48, is estimated by Danson at $57,052,034, and of gold for 40 years from 1809–48, $16,115,522.

The Bolivian mint coined in 1849 $1,621,536 in silver, and $11,984 in gold. Much silver is smuggled out of the country to avoid the payment of government dues. The official record of production of gold and silver from 1800 to 1846, inclusive, is as follows:[1]

1800 to 1806	$21, 186, 460	1831	$9, 784, 620
1811	16, 288, 590	1836	9, 848, 342
1816	10, 789, 816	1841	9, 678, 420
1821	9, 749, 350	1846	9, 789, 640
1826	9, 089, 787		

In the Cerro de Potosi and vicinity, in 1851, 26 mines were being worked, and 18 were neglected. According to the government records there were in the mining districts of Porco, Chayanta, Chichas and La Paz 3,089 abandoned silver mines, and only 85 worked.[2]

[1] Report to United States government by Lieutenant Lardner Gibbon, 1853. [2] Ibid.

CHAPTER VI.

SILVER REGIONS OF EUROPE AND ASIA.

REPRESENTATION OF THE SILVER-LEAD MINES OF FRANCE AT THE EXHIBITION—SPAIN—ITALY AND SARDINIAN MINES—AUSTRIA—SAXONY—PRUSSIA—ARGENTIFEROUS LEAD ORES OF THE UNITED KINGDOM—PORTUGAL—RUSSIA—ORES OF SILVER AND LEAD AT THE EXHIBITION—KONGSBERG SILVER MINES OF NORWAY—TABLE OF PRODUCTION AND PROFITS—SPECIMENS EXHIBITED AT PARIS—SWEDEN—TURKEY—ALGERIA—CHINA—JAPANESE SILVER MINES AND EXPORTS.

FRANCE.

The silver produced in France is almost all derived from silver-lead ores obtained in great part from Sardinia, Algeria, Germany, and Spain. The production is divided between the following departments: Bouches-du-Rhone, Finistère, Isère, Lozère, Pas-de-Calais, Puy-de-Dome, and Seine-Inférieure.

The ores and products of the following companies and establishments were exhibited:

Upper Alps Silver Mining Company—Suquet Jun. & Company.—Argentiferous lead ores in various stages of preparation.

Pontgibaud Lead and Silver Mining and Smelting Company—Puy-de-Dome, 24 Rue Richer, Paris.—This company made an extensive and brilliant display of the lead ores and products of their works, arranged tastefully in a large glass case. The ore was shown in large masses, and in the various stages of mechanical preparation. The products were lead in ingots, large bars, rods, and sheets. The silver extracted from the lead was shown in a very large mass, nearly a yard in diameter, just as it came from the cupel, and it was valued at 135,000 francs, ($27,000.) The ores are from different localities, and have in general the following values in lead and silver:

	Lead.	Silver
Pzual, in 1,000 parts	620	2.450
La Grange, in 1,000 parts	287.50	1.087
Brousse, in 1,000 parts	730	3.600

The rich lead in bars contains .017 of silver, and the working lead 3.850.

Mines of Meyrneis, Loire—Eugene Joly, director.—Argentiferous lead and copper ores.

Villefort and Vialas Lead and Silver Mines Company—Lozere.—Paris, 13 Rue Bonaparte. Lead and silver ores, showing the mechanical preparation and the extraction of silver, together with a plan of the mines.

Lead and silver mines of Argentière—Bessee sur Durance, High Alps.—Granular galena in calcareous gangue. A large mass contains: lead, 43

per cent.; silver, 144 grams per 100 kilograms of ore, or 435 grams per 100 kilograms of lead. The following is the general average of the ores in silver and lead:

Ore of first quality: Lead, 45 per cent.; silver, 200 grams to 100 kilograms of ore, 444 grams to 100 kilograms of lead.

Ore of second quality: Lead, 40 per cent.; silver, 174 grams to 100 kilograms of ore, 434 grams to 100 kilograms of metal.

Ore of third quality: Lead, 38 per cent.; silver, 163 grams to 100 kilograms of ore, 430 grams to 100 kilograms of lead.

Urciers and Lignerolles argentiferous lead mines.—I. Javal, exhibitor. Argentiferous lead ores, with sulphuret, phosphate, and carbonate of lead.

Lead, Copper, and Silver Mining Company of the Ardillats—Rhone.—Ores and their products.

Ste-Foy silver mines.—Rhone.

Rigandeaux, Perdraux.—A. A. Clermont.

Terrand, Puy-de-Dome.—Argentiferous lead ores.

Gennamari and Ingurtosu—Sardinia, French Company.—The display made by this establishment includes specimens of massive galena with a fibrous structure and brilliant fracture. Some specimens are compact and granular. The ores yield as follows:

1. *Gennamari:*

Lead	76 to 81 kilograms in 100 kilograms.
Silver	60 to 66 grams in 100 kilograms.

2. *Ingurtosu:*

Lead	76 to 78 kilograms in 100 kilograms.
Silver	24 to 34 grams in 100 kilograms.

It was not possible to obtain recent statistics of the annual production of silver by these different establishments. According to Dalloz there were, in 1852, six argentiferous lead mines in the Puy-de-Dome, and four in Lozère. In 1858, eleven were under exploitation, and among them those of Poullaouen and Huelgoat, in Finistère; of Pontpéan, in Ille-et-Vilaine, and Vialas in Lozère, and Pontgibaud in Puy-de-Dome. The ores from the last mentioned locality, in 1847, yielded 344 kilograms of silver, worth 673,674 francs. In 1851 the production of silver amounted to 1,522,874 francs, about $300,000. According to M. Oeschger, quoted by Dalloz, from 5,000 to 6,000 tons of argentiferous lead ores are smelted and desilverized in France annually. The following table shows the weight and value of the silver extraction in France from 1853 to 1859, inclusive:[1]

[1] Compiled from Statistique de l'Industrie Minérale—Résumé des Travaux Statistiques de l'Administration des Mines. 1860.

Production of silver in France.

Year.	Weight, kilograms.	Value in francs.
1853	8,920	1,935,879
1854	16,258	3,544,817
1855	9,061	1,981,522
1856	26,477	7,012,876
1857	45,224	10,196,820
1858	47,508	11,716,036
1859	48,591	10,959,013
Total	202,039	47,346,963

SPAIN.

In the large and interesting exhibition of the various mineral productions of Spain, several of the most important silver mines and districts were represented.

The silver mines of this country were worked in the most remote periods, and by the Phœnicians, Romans, and Moors in turn. The mines of Guadalcanal and Cazalla are in mica slate, but are not now productive. The most important mines are those of Hiendelaencina, about 70 miles north of Madrid, in the province of Guadalajara. They were discovered in 1843. The vein traverses gneiss and coarse talcose slate, in an east and west direction, and with a southerly dip. The veinstone is sulphate of baryta with a little quartz, and some spathic iron. The most abundant ore is silver glance, and the average yield is about 90 ounces per ton. The mines have been worked to a depth of about 1,200 feet, and since 1858 the yield has declined. The production of these mines since 1846, up to July, 1866, a period of 19½ years, was 7,578,536 English ounces of fine silver, an average of about $450,000 a year.[1]

According to M. Petitgand[2] the value of the silver production in Spain from 1841 to 1848, eight years, was 50,329,895 francs. In 1854 it was 1,013,948 ounces, and in 1855 it was valued at 11,200,000 francs.[3] In 1858 the production amounted to 101,684 marks.[4] The official catalogue, issued by the royal commission of Spain at the Exposition, was accompanied by some statistics of the metal production of the country, from which the following figures are taken. In the year 1863 the production of lead ores, argentiferous lead ores, and of silver, was as follows:

	Metric quintals.	Écus.[5]
Lead ores	2.695.989	9.415.351,4 (lead ores and argentiferous lead ores together)
Argentiferous lead ores	403.395	
Silver ores	30.616	612.320,0

[1] Phillips's Mining and Metallurgy of Gold and Silver, pp. 263,264.

[2] Exploitation et du traitement des minerais de plomb dans le midi de l'Espagne, p. 27.

[3] Ostrechkoff; cited by Dalloz, p. 425.

[4] M. Léon Vidal; l'Espagne en 1860.

[5] The value of the *écu* is not stated, and it is difficult to ascertain what value is intended It is probably 2,375 francs. The punctuation of the figures is given as in the original.

Value of the production of metallurgical establishments:

		Reals.
Lead	627,679 metric quintals, value	8,787,506.000
Silver	13,759,54 kilograms, value........	1,128,282.280

Much of the silver is extracted from galena by Pattinson's process, or by cupellation. The true silver ores are amalgamated by the German method at a fine establishment in Guadalajara.

ITALY.

The silver ores in the Italian section of the Exposition were chiefly argentiferous galena, and from the island of Sardinia. A collection from this island, exhibited in the French section, has already been noticed.

In Tuscany the lead-bearing formation is a micaceous schist. The formations of Monteleone are calcareous, and carry sulphuret of lead mixed with fluor spar of various colors, and with quartz. In the Neapolitan provinces, at Longobucco, a similar association of the ore is united with blende, and contains 70 per cent. of lead and 0.0751 of silver. The ore is also found mixed with antimony and sulphate of barytes, and contains 30 per cent. of lead and 0.1515 of silver.

The most important deposits are in Sardinia, in crystalline argillaceous and micaceous or talcose schists of the Secondary and Tertiary periods. The most abundant deposits are in the province of Iglesias, where over 100 localities may be counted that are more or less remarkable, and are now or have been worked.

The various ores and products of these Sardinian mines were accompanied by a very interesting published description, by M. Léon Goüin, engineer of mines,[1] from which the following information is chiefly derived.

The best ores are those of Monteponi, which contain 80 to 81 per cent. of lead, and about 20 grams of silver per 100 kilograms. The gangue of these ores is limestone, somewhat ferruginous, and "very fusible." Around this mine are grouped the mines of San Giorgio, San Giovanni d'Iglesias, and San Giovanni de Gonnesa. All the deposits of the region are in limestone, ferruginous, magnesian, and sometimes silicious. The ores of Ingurtosu, of Gennamari, and of Crabulazzu are second in rank, and give from 76 to 80 per cent. of lead, and from 34 to 50 grams of silver. Their gangue is quartz, carbonate of iron, carbonate of lime, blende, and pyrites. The ores of Montevecchio are third in rank, and being somewhat refractory, are not so desirable. The gangue is rich in quartz, blende, and iron and copper pyrites.

The annual production of argentiferous lead ores in Sardinia is increasing, according to the official statistics given of the yield of 29

[1] Notice sur les Mines de l'Ile de Sardaigne; pour l'explication de la collection des minerais envoyes à l'Exposition Universelle de Paris pour 1867, par Léon Goüin, ingenieur civil des mines. Large 8vo. Cagliari, 1867.

different mines. The following are the totals from 1859 to 1865, inclusive:

	Metric quintals.		Metric quintals.
1859	78,642	1863	134,722
1860	133,538	1864	161,277
1861	141,240	1865	247,472
1862	147,560		

These ores ranged from 33 to 80 per cent. of lead, and from 10 grams of silver to, generally, 38 to 40 grams of silver per 100 kilograms.

Total annual production of silver.—The annual production of the lead mines and smelting works of Italy in 1862 was nearly as follows:[1]

Galena exported, containing an average of 70 per cent. of lead and 5 to 6 ounces of silver per ton	10, 000 tons.
Lead	5, 000 tons.
Silver, 3 tons, or nearly 96,000 ounces	3 tons.

At the present time, according to the statistics given at the Exposition,[2] the production is—

		Value in francs.
Lead, metric quintals	129, 361	5, 986, 758
Silver, grams	6, 625, 919	1, 409, 235
Litharge, kilograms	29, 885	13, 448

Six hundred workmen are employed, and the annual expenditure for labor is 359,650 francs.

AUSTRIA.

The mines and mineral productions of this empire were illustrated by very complete collections of the ores and their products, and by models of the mines and furnaces, together with very elaborate geological maps and sections of mines. The chief localities of silver are in Bohemia and Hungary. In the former, at the mines of Prag, Elbogen, and Kommotan; in Hungary, at Neusohl Kaschau, Nagybanya, and Oravicza. The total production of silver ores, from both private and government works, in the year 1865, was 2,543,850 hundred-weight, (Vienna,) valued at 3,092,385 florins. The production of silver for the same period was 81,700 Vienna pounds, valued at 3,678,354 florins,[3] about $1,819,000.

According to M. de Carnall, and official statistics,[4] the production of silver from 1855 to 1859 was as follows:

	Kilograms.		Kilograms.
1855	35, 016.318	1858	51, 858.654
1856	59, 615.450	1859	34, 527.150
1857	53, 394.750		

[1] Official Descriptive Catalogue. Kingdom of Italy. International Exhibition of 1862.
[2] Italie Economique in 1867.
[3] From statistical tables in Der Bergwerks, Betrieb in Kaiserthume Oesterreich, fur das Jahr, 1865. Wien, 1867.
[4] Cited by Dalloz, De la Propriete des Mines, ii, 297.

Phillips states that the mines of Hungary, Transylvania, and the Banat produce about 92,000 pounds, troy, of silver annually.

SAXONY.

The nature of the Saxon ores, and the processes for their reduction, were illustrated in the Exposition by very complete and interesting series of specimens. The Erzegebirge or "Ore Mountains range," on the western side of the Elbe, is divided into four mining districts, as follows: Altenberg, 31 mines; Freiberg, 98; Marienberg, 48; Schwarzenberg, 146. Of these mines only 20 are worked by the government; the others are explored by companies and private capital. In the year 1865 the amount of first-class ores delivered at the Freiberg smelting works was about 33,614 tons, worth about $1,017,305 in the raw state, or an average of $30 per ton. These ores, when worked, gave products to the value of about $2,000,000, of which nearly $1,403,862 in value was fine silver. The total yield of silver from the mines of Freiberg, from 1524 to the end of 1850, was 5,613,228 pounds troy.

PRUSSIA.

According to the catalogue accompanying the Prussian exhibit in Group V, Class 40, there are now in that country only two localities of any importance for their production of silver. These are Andreasberg, in the Hartz, and the vein Gondersbach, at Laasphe. A third locality of little importance is at Müsen and Littfeld. The ores of all three of these localities were exhibited.

The veins at Andreasberg and at Laasphe are in greywake of the Devonian period. The ores at Andreasberg are native silver, antimonial silver, and ruby silver. At Laasphe they are native silver, silver glance, and dark red silver ore. At Müsen, native silver, and argentiferous gray copper ore. No statistics of production were given.

The mines at Andreasberg were discovered in 1520, and the Samson vein has been worked to a depth of over 2,500 feet. The veins are considered to be exhausted at this great depth, and the present supply of ore is probably obtained much nearer the surface. The annual production from the mines of the Hartz, according to Phillips, is 27,540 pounds troy.

UNITED KINGDOM OF GREAT BRITAIN.

The argentiferous lead ores of Great Britain are the only source of its silver production, which averages about 600,000 ounces a year. The following tabular statement, received from the Mining Record Office, shows the production of lead and silver for the 10 years from 1856 to 1867.

Lead ore, lead, and silver produce of the United Kingdom of Great Britain for the ten years ending 1866.

Year.	Lead ore.	Lead.	Silver.
	Tons.	*Tons.*	*Ounces.*
1857	96, 820	69, 266	532, 866
1858	95, 855	68, 303	569, 345
1859	91, 381	63, 233	576, 027
1860	89, 081	63, 525	549, 720
1861	90, 696	65, 643	569, 530
1862	95, 311	69, 013	686, 123
1863	91, 283	68, 220	634, 004
1864	94, 433	67, 081	641, 088
1865	90, 452	67, 181	724, 856
1866	91, 047	67, 390	636, 188

This shows an average of over 600,000 ounces a year, or a value of about $750,000. The total value of the silver produced in the five years ending 1858 was £724,395, which is an average of about $725,000 per annum.

Most of this silver is extracted by Pattinson's process. The amount of silver per ton of lead varies from 10 ounces, and less, to 140 ounces. In general the ores from the north of England do not contain over 1½ ounces of silver per ton. The ores of the Isle of Man yield from 50 to 60 ounces of silver per ton of lead. Those of Cardiganshire and Montgomeryshire contain from 15 to 25 ounces. The Cornish ores contain on an average about 30 ounces of silver per ton.[1]

PORTUGAL.

The Lusitanian Mining Company and the company of the mine of Telhadella exhibited specimens of galena and silver lead ores, and A. A. Pinto, of Oporto, contributed specimens of native silver and silver lead ores from the mine of Varzea de Trovons. The production of silver is comparatively insignificant, but no statistics were obtained.

SWITZERLAND.

Baglioni & Co. exhibited specimens of argentiferous copper ores from Xamins, Grisons; and the company of the mines of the valley of Schams, Andeer, Grisons, displayed specimens of argentiferous lead.

RUSSIA.

The mineral collections sent to the Exposition from Russia contained numerous specimens and illustrative series of specimens from several of the mines and establishments for the production and working of argentiferous galena and other ores of silver.

The chief localities of silver, lead, and copper are in the Great and Little Altai mountains, in the Ssalaire chain, and in the group of Karkaralinsk

[1] Phillips's Mining and Metallurgy of Gold and Silver, p. 252.

and the chain of mountains beyond Lake Baikal. Silver ores are also found in the district of Aertschinsk, and in the Caucasus, (mines of Alaghir.) All the mines of silver and lead are the property of the Emperor, with the exception of those of Alaghir, which belong to the state. Recently mines of silver-lead have been opened in the Kirghese steppes, at Karkaralinsk.[1]

The exploitation of silver in Russia dates from the reign of Peter the Great. The first vein or deposit was discovered in 1691, in the district of Nertschinsk, upon the river Arghoumi, near the ancient "puits Finnois."[2]

The principal mines of the Altai region were discovered in 1739 by T. C. Demidoff. The ores of silver and gold are smelted in five establishments, at Barnaoul, Pavlovsk, Garrilov [illegible], Tmeivsk, and Loktevsk. These extract about 1,050 poods of silver of [illegible]0 per cent., containing about 55 poods of gold.[3]

In regard to the total m[illegible] silver in this country, Messrs. Tchevkine and Ozersky h[illegible]s [illegible] that up to 1851 it amounted to 108,719 poods, more than 1,800 [illegible]grams, which is in close accordance with the figures given by [illegible]enko-Otreschkoff, who estimates the amount for the same period [illegible],083 kilograms.[4] From 1851 to 1855 the last-mentioned [illegible]mates the production at 68,426 kilograms, valued at 15,215,200 fra[illegible]. This is about 17,000 kilograms a year, which is nearly the same as the present production, according to the statistics published at the Exposition and presented in the following table from official sources:[5]

Production of the silver and lead mines of Russia for 1863.

Districts.	Silver.			Lead.	
	Poods.	*l.*	*Kilograms.*	*Poods.*	*Quintals.*
Nertschinsk	1,044	29	171,233	64,902	10,817
Altai	7	21	1,234	631	105
Mine d'Alaghir	25	20	4,180	5,210	868
Kirghese steppes		35	135	977	162
Total	1,078	25	176,782	71,720	11,952

The silver production is valued at 852,410 roubles, (3,409,640 francs, or about $681,928.) Total value of the lead, about 580,000 francs, or $116,000.

According to Phillips, the most important silver mine of the Altai is Zméof, which is opened on a great vein, bearing argentiferous native gold, native silver, and sulphide of silver, together with ores of copper. The principal vein is worked to a depth of 95 fathoms.

[1] Apercu Statistique de la Russie.
[2] Dalloz, de la Propriete des Mines, ii, 338.
[3] Catalogue Special de la Section Russe, Expos. Univ., 1867.
[4] Vide Dalloz, de la Propriete des Mines, &c., ii, p. 340.
[5] Apercu Statistique des Forces Productive de la Russie, p. 144.

The Exhibition contained specimens from the mines of the Altai, sent by the administration of mines for the government of Tomsk, and included specimens from Biysk, Kouznetsk, and Barnaoul.

Argentiferous lead mine of Yiransk.—The ores occur in argillaceous talcose and chloritic slate. The oxidized ores contain 3½ to 7 zolontiks of silver to the pood[1]=15 grams to 29 grams in 16.3 kilograms. The ores from greater depths are argentiferous sulphuret of copper and argentiferous blende.

Silver mine of Sokol.—In argillaceous and silicious schist. The oxidized ores contain 1¾ to 2½ zolontiks of silver per pood.

Mines of Salairsk.—Vein of Soimonovsk. The oxidized ores contain ⅝ to 1 zolontik per pood.

Lead works of Barnaoul.—This display contained: 1. The secondary and intermediate products of the smelting, such as scoriæ, matts, litharge, &c. 2. The materials used for the construction of the furnaces and during the smelting, such as Glauber's salt, limestone, fire-bricks, fire-clays, stone used for the tymp and the crucible of the furnace. 3. The lead containing silver, (12 zolontiks per pood,) and the lead after the first, second, and third stages of desilverization. 4. The fine silver.

Kirghese Steppes, Siberia.—Ores of copper, lead, argentiferous lead, iron, and coal, exhibited by Nicholas and Alexander Popoff, (No. 499 Catalogue Special.) A large specimen of native copper in this display was found to contain a small mass of native silver, attached to the copper as perfectly as in the specimens of native silver and copper of Lake Superior. The lead ores of Bogoslovsk contain 42 per cent. of lead and three zolontiks of silver per pood.

There are five mines of argentiferous lead in this region, which give ores containing from 1½ to 20 zolontiks of silver to the pood, and from 40 to 60 per cent. of lead.

Medvége island.—Ores of silver with the gangue, exhibited by Michael Sidoroff.

NORWAY.

The celebrated silver mines of Kongsberg were represented in the Exposition by a very complete and interesting series of the ores and the enclosing rocks, together with several maps and vertical and cross sections of the veins and workings of the mine. The specimens of crystallization of silver and its ores were remarkable for their size and perfection.

The following statistical data are derived from information furnished to the writer by Mr. Stahlsberg, the chief engineer of the mines, (September, 1867:)

These mines were discovered in 1624, and have been worked by the government since 1814. The number of veins in the district is very great, but only a few of them are worked. They traverse crystalline

[1] 1 pood=16.380 kilograms; 1 zolontik=4.266 grams.

micaceous and hornblendic schists, trend nearly northwest and sou east, and are nearly vertical. In width they vary from a few millimet to one or two feet, but are generally from four to eight inches thi They can be followed horizontally for a distance of 600 feet or more, l the ores are found within but a small portion of this distance, bei usually confined to a few fathoms upon the course of the vein. T greater part of the silver is in the metallic state, partly disseminated the gangue, but often in nests or bunches of large size, and in cryst as shown at the Exposition. The gangue is chiefly calcareous spar, w a little fluor spar and quartz.

The veins are opened by shafts and an adit. Only four shafts are n in use out of 200 which were formerly worked. The number of min toward the close of the last century was about 4,000; now, only ab 400 are employed. The vertical depth reached by some of the shafts about 550 metres, or nearly 280 fathoms (1,680 feet) from the surfa The King's mine, which is now the richest, has reached this depth, a the collection contains a rich specimen from the bottom. An adit driven in to intersect this mine, and drains it to a depth of 300 metr about 975 feet. This adit is 2,000 metres (6,563 feet) in length.

The total production of the mines from the discovery to 1866 inclusi 242 years, amounts to 820,000 kilograms of fine silver. The annual p duction in the last 40 years has varied from 3,500 to 8,000 kilograms fine silver.

The following tables of the production, expenses, and profits are giv by Mr. Phillips,[1] and are derived from official sources.

The total production for different years was as follows:

From 1624 to 1805...	2, 360, 140 marks,[2]	equal to	1, 332, 495	pounds tr
From 1805 to 1815...	38, 112	" "	21, 517	"
From 1815 to 1864...	820, 956	" "	463, 498	"

The average annual produce has been—

From 1815 to 1833........	4, 141	marks, equal to	2, 338	pounds tro
From 1834 to 1838........	27, 423	"	15, 483	"
From 1839 to 1843........	25, 454	"	14, 361	"
From 1844 to 1848........	23, 464	"	13, 247	"
From 1849 to 1853........	20, 552	"	11, 603	"
From 1854 to 1858........	32, 862	"	18, 553	"
From 1859 to 1863........	16, 091	"	9, 084	"

From 1859 to 1864 the annual yield has been—

1859....................	20, 515	marks, equal to	11, 582	pounds troy
1860....................	18, 139	"	10, 241	"
1861....................	14, 823	"	8, 369	"
1862....................	13, 088	"	7, 389	"
1863....................	13, 890	"	7, 842	"
1864....................	13, 046	"	7, 365	"

[1] Metallurgy of Gold and Silver, pp. 254, 255.

[2] The mark of Norway and Sweden is equivalent to 3.252 grams, or 6.775 oz. troy.

In addition to the mines of Kongsberg, some veins in the district of Skara were formerly of considerable importance, but are now abandoned, although the fahlbands of this locality closely resemble those which have proved so productive in the adjoining district.

The produce, expenses, and net profits of the Kongsberg mines during the last 31 years have been as follows:

Statistics of the Kongsberg mines.

Year.	Produce sold.	Expenses.	Net profit.	Year.	Produce sold.	Expenses.	Net profit.
1834..........	£87, 558	£17, 407	£70, 151	1851..........	£38, 140	£15, 975	£22, 165
1835..........	50, 171	16, 215	33, 956	1852..........	40, 770	16, 905	23, 865
1836..........	70, 244	13, 585	56, 659	1853..........	36, 363	16, 444	19, 919
1837..........	52, 087	21, 015	31, 072	1854..........	51, 616	17, 984	33, 632
1838..........	58, 137	21, 258	36 879	1855..........	82, 448	20, 294	62, 154
1839..........	69, 879	20, 110	49, 769	1856..........	66, 922	19, 613	47, 309
1840..........	64, 236	20, 497	43, 739	1857..........	49, 627	17, 886	31, 741
1841..........	50, 009	22, 030	27, 979	1858..........	84, 356	20, 136	64, 220
1842..........	42, 915	19, 524	23, 391	1859..........	41, 888	20, 996	20, 892
1843..........	41, 398	19, 811	21, 587	1860..........	37, 157	23, 420	13, 737
1844..........	39, 462	18, 117	21, 345	1861..........	30, 141	24, 037	6, 104
1845..........	36, 772	16, 462	20, 310	1862..........	26, 708	20, 551	6, 157
1846..........	37, 297	12, 642	24, 655	1863..........	28, 836	20, 982	7, 854
1847..........	51, 831	19, 146	30, 685	1864..........	28, 090	21, 171	6, 919
1848..........	75, 788	16, 268	59, 520				
1849..........	49, 934	18, 621	31, 313	Averages...	£50, 750	£18, 885	£31, 704
1850..........	47, 518	16, 362	31, 156				

Among the specimens exhibited the following may be particularly noted for their beauty and rarity as crystallizations:

1. A cube of silver (crystal) three-quarters of an inch in diameter, with small and perfect octahedral planes.

2. A group of modified cubic crystals, the whole mass as large as one's fist and composed of some twenty or thirty-five crystals, all of them remarkable (as are most of the specimens from this locality) for their whiteness and brilliancy. There is a little calcite between the crystals.

3. Curiously distorted crystals in a large mass. These crystals are nearly two inches long, half an inch in diameter, and are apparently elongated cubes, curved and tapering to a point.

4. Filamentous or wire silver, in long and large masses.

5. Sulphuret of silver, a large mass.

6. Sulphuret of silver, "antimonial" (pyrargyrite?) A fine hexagonal crystal three-quarters of an inch in diameter and nearly half an inch long.

7. A large mass of dendritic crystals of sulphuret of silver.

8. Calcite penetrated by wire silver, exactly as native copper penetrates the calcite at Lake Superior.

In addition, there were some specimens of the stamped and dressed ores. The washed product contains 90 per cent. of silver, the schlichs from 1 to 1-30th of 1 per cent. of silver. The best ores may be said to contain 50 to 60 per cent. of silver, and the second class from 2 to 5 per

cent. Some large masses of native silver of irregular form attracted great attention. Pieces have often been found that weighed 100 kilo grams, about 220 pounds, and some even much more. In June of this year (1867) a single blast threw out one mass of native silver mixed with sulphuret weighing 160 kilograms, (352 pounds,) and another weighing 125 kilograms, (275 pounds.) A specimen from these mines in the roya collection at Copenhagen weighs upwards of five hundred pounds.

SWEDEN.

After iron, the principal metals of Sweden are silver, copper and lead The first two were formerly produced in much greater quantities than of late years, but the production of lead has recently increased so much that it is exported. It is obtained chiefly in the extraction of silver from galena.

The principal silver mine is at Sala in Westmannia, and yielded 1,82(pounds of pure silver in 1865, but in the 17th century it was one of the most productive in Europe.[1] This mine is said to have been worked over 500 years ago, and to have yielded in 1506 35,000 marks of silver (about 19,600 pounds troy.) It was re-opened in 1623, and in 1830 was said to be yielding 1,700 marks annually. The ore is a highly argentiferous galena.

Two other silver mines were worked in 1767, viz: Hellefors in the province of Wermland, and Segersfors in Nericia, but no account of them is given in the recent statistical publication by Ljungberg.

TURKEY.

The Ottoman government made extensive exhibitions of argentiferous lead ores from the following mines and localities: Mines of Hazme Maghara, Hydgr, Ilias, Palata, Hassan, Ananias, Tirvir, Essad, Agha, and Koptcha; so, also, from Silvas and Amasia, and from Biga, Khodavendhiger, from the mines of Djerbiler, Milli, Kara Dagb, and Elmadjik.

ALGERIA.

The following mines and mining companies were represented by collections and specimens at the Exposition:

Kef-oum-Thebad—Silver lead company, Constantine.—Silver lead ores.

Djidjeli—Constantine, (S. Trabet, exhibitor.)—Iron, silver, copper and antimony ores.

Rouban, Gas Mines Company.—Silver lead ore.

Blidah Mines Company.—Copper and silver lead ores, and an ingot of silver.

Phillipeville—Constantine.—Silver lead ore.

[1] La Suède, son development, moral, industriel et commerciel, d'apres des documents officiels, par C. E. Ljungberg. Traduit par L. de Lilliehook. Paris, 8vo, 1867.

CHINA.

Mr. Williams states that from a memorial addressed to the Emperor of China, in 1838, it appears that most of the native silver is obtained from mines at Hoshan, in Yunnan, in the department of Tsiangchau, and at Sungsing on the borders of Cochin China. These mines are farmed out by the government to overseers, and between forty and fifty thousand workmen are employed in them who annually produce not far from 2,000,000 of taels of silver. There are other mines not so rich as these two, but which produce large amounts.[1] It is further observed that it is impossible to even guess what China receives annually from her gold and silver mines.

The following are some of the localities of silver, but many of them, probably, furnish only argentiferous lead.[2]

PROVINCE OF CHIHLI.

Shuntien (Fu) or Peking.—Silver at Mount Yunyen, 15 li south of Meyun, (hien.) Silver at Sz'ling 100 li[3] northeast of Meyun.

Yungping, (Fu.)—Silver 130 li northwest of Tsiengan, (hien;) silver at Mount Tsu, 15 li west of Lulung, (hien.) Also at Mount Yuhwang, 90 li northeast of Funing.

Siuenhwa, (Fu.)—Silver in Yu, (chau.)

PROVINCE OF SHANSI.

Kiai, (chau.)—Silver in Ngani. In Pingloh (hien) silver in several localities.

PROVINCE OF SHENSI.

Singan, (Fu.)—Silver; also at Shang, (chau.)

PROVINCE OF KANSUH.

Pingliang, (Fu.)—Silver and copper in Pingliang, (hien.) Silver and copper in Hwating, (hien.)

Kungchang, (Fu.)—Silver and copper at Mount Ningkwei, 30 li south of Ningyuen.

Tsin, (chau.)—Silver at Mount Tayang, 50 li northeast of Liangtang, (hien.) Silver in Tsingshui (hien.)

PROVINCE OF SHANTUNG.

Ichau, (Fu.)—Silver in the vicinity of gold ores at Mount Pau, 90 li southwest of Lanshan, (hien.) Silver with gold and tin at Mount Chipau, 100 li north of Ku, (chau.)

---

[1] Chinese Commercial Guide, 4th edition. Canton, 1856, p. 295.

[2] This list is compiled from the volume entitled Geological Researches in China, Mongolia, and Japan, by Raphael Pumpelly. Smithsonian contributions; October, 1866.

[3] One *li* equals 1,897¼ English feet, or 2.78 li a mile. A modern li, however, is one-tenth of a French league, or 1,460.44 feet.

Mungying, (hien.)—Silver at Mount Leanghien.

Tsingchau, (Fu.)—Silver, lead, copper, and gold sands at Mount Tung, 60 li southwest of Linku, (hien.)

PROVINCE OF NGANHWUI.

Hwuichau.—Silver and lead.

PROVINCE OF SZ'CHUEN.

Mien, (ch[illegible] —Silver and tin.

Ningyue[illegible]*u.)*—Silver at Mount Miloh, 200 li east of Hwuili, (chau;) also, at M[illegible] Kosowa.

PROVINCE OF KIANGSI.

Kwangsin, (Fu.)—Sil[illegible]t[illegible] hien,) and Yushan, (hien.)

Kiengchang, (Fu.)—Silver i[illegible]g.

Fuchau, (Fu.)—Silver i[illegible].)

Linkiang, (Fu.)—Silver [illegible]ien.)

[illegible] HUNAN.

Changsha, (Fu.)—Silver, c[illegible] tin, and quicksilver.

Hangchau, (Fu,) and at Yu[illegible]*u.)*—Silver and tin.

Pauking, (Fu.)—Silver.

Kweiyang, (chau,) and at Yochau, [illegible].)—Silver, copper and lead.

PROVINCE OF CHEHKIANG.

Taichau, (Fu.)—Silver and lead at Mount Tientai and Mount Tsz'hien, in Tientai, (hien.)

Kuchau, (Fu.)—Silver ore, yielding $300 to the ton, at Mount Yinkung, in Changshan, (hien.) Silver, also, at Mount Yinkung, in Suingan, (hien.)

Yenchau.—Silver at Mount Yin.

Wanchau (Fu.)—In Pingyang, (hien.) Silver at Mount Chauki, Mount Ts'zye, and Tientsingyang. Silver on the Chauchi river, in Tisung (hien.)

PROVINCE OF FUHKIEN.

Kienning, (Fu.)—Silver in the hiens, Kienngan, Kienyang, Pusung and Tsungho, Tingchau, (Fu.) Silver at Lungmuntsang, in Ninghwa, (hien.) Silver at Wangpeitsang and Nganfungtsang, in Tsangting, (hien.)

PROVINCE OF KWANGTUNG.

Kwangchau, (Fu,) or Canton.—Silver at Tashui Kung, in Nanhai, (hien,) and at Peyinkung, in Sinhwui, (hien.)

Lienchau, (Fu.)—Silver. Lead and cinnabar in Yangshau, (hien.)

Shanking, (Fu,) and Kiungchau, (Fu.)—Silver.

PROVINCE OF KWANGSI.

Kweilin, (Fu.)—Silver and cinnabar.

Liuchau, (Fu.)—Silver in Siang, (chau.)

Kingyuen, (Fu.)—Silver at Mount Mongin, 35 li northwest of Hochi, (chau.)

Pingloh, (Fu.)—Silver in Pingloh, (hien.) Silver and tin in Fuchuen, (hien.) Silver at Taipingyintsang in Ho, (hien.)

Sinchau, (Fu.)—Silver and lead in Kwei, (hien.)

PROVINCE OF YUNNAN.

Tsuhhiung, (Fu.)—Silver in Kwangtung, (hien,) and at Soyangtsang and Malungtsang, in Ngau, (chau,) and with lead at Yuntsungtsang in Tsuhhiung, (hien.)

Kwangsi, (chau.)—Silver and lead at Mount Peting.

Kiuhtsing, (Fu.)—Silver and lead at Mount Yang, west of Siuenwei, (chau.)

Wuting, (chau.)—Silver at Sutsuweitsang.

Pu'rh, (Fu.)—Silver at Pema, Kanku, and Mantau, in Sihma, (ting.

Yungchang and Tungchuen, (Fu.)—Silver.

Chautung, (Fu.)—Silver at Lutientsang and Lomatsang, at Tungputsang in Chinhiung, (chau,) and at Kinshatsang, in Yunseh, (hien.)

JAPAN.

There are no reliable statistics or estimates of the amount of silver produced in this empire. There are rich silver veins in some of the islands, and particularly at Sado, where mines have been worked for a long time. It is certain, however, that at the present time a large part of the silver used at the Japanese government mints in the coinage of itzeboos is supplied by Mexican dollars, and other foreign silver coins, taken in exchange at the custom houses.

Formerly, during the period of the Portuguese and Dutch trade, large quantities of silver were drawn from the country in exchange for Chinese commodities. The Portugese trade continued for 90 years, ending in 1638. For about half of this period they sent only one ship in each year, and she returned with about 600,000 *crusados*, about as many dollars.[1] If we allow that the annual trade for the whole period averaged \$500,000 a year, a low estimate, the total export of silver was \$45,000,000. The trade with the Dutch began in 1609, and it so rapidly drained the country of its bullion that it required government interference, and the export of silver was prohibited. According to Arrai Tsikugo-no-kami,[2] the exports of silver from 1611 to 1706 amounted to 112,268,700 taels,[3] about \$161,343,500. Among the exports by the Dutch, during the last year of their occupation of Desima, were 1,400 chests of silver, each containing 1,000 taels, or nearly \$2,000,000.

[1] *Vide* the account of the Portuguese trade by Ralph Fitch, cited by Hildreth. Japan as It Is and Was, p. 206.

[2] Origin of the Riches of Japan, (1708.) Translated by Klaproth; Nouveau Journal Asiatique.

[3] The Chinese tael is worth about \$1 40.

PLATINUM AND OTHER METALS.

CHAPTER VII.

PLATINUM, PLATINUM APPARATUS, PLATIN-IRIDIUM, AND OTHER RARE METALS.

EXHIBITION OF PLATINU[illegible]CTION OF THE METAL—CALIFORNIA AND OREGON-[illegible]ROM PORT ORFORD—PLATINUM STILLS AND OTH[illegible]S, MATTHEY & CO.—LARGE PLATINUM INGOTS—PLATINUM[illegible]ESIUM—IRIDIUM—OSMIUM—SERIES OF METALS IN SPECIMENS[illegible]MEDALS AWARDED—QUICKSILVER ORES OF CALIFORNIA AND SPA[illegible]PACIFIC COAST MINES.

Paul Demidoff, [illegible]f Perm, exhibited a variety of samples of native [illegible]s localities on his mining estates. One of these specimens was a nugget of the metal, six inches in its greatest diameter, weighing 11¾ livres, (13 pounds troy.)

Some of the samples were in fine grains and scales as separated from placer gold by amalgamation. This platinum is refined at the establishment of the exhibitor and sold at the rate of 3,100 roubles (12,400 francs) the pood, (16.380 kilograms,) delivered free of charge at Paris. There are 20 localities of platinum known upon the estates of this exhibitor, and the production of the washings since 1825 has been about 3,105 poods, but a great part of the localities are reserved. This amount corresponds to 50,859.9 kilograms, or 1,635,993.45 troy ounces. Its value, at 3,100 roubles per pood, is about $7,700,400.

A very interesting exhibit of native platinum, and the metals which usually accompany it, was made by the St. Petersburg mint, (No. 505 of the special Russian catalogue.) This collection consisted of—

	Roubles.
1. *a* Native platinum, value per livre	42.02
b Refined platinum in the state of sponge and in ingots	62.50
2. Products of refining platinum—	
a Iridosmine, value per zolotnik	0.85
b Insoluble precipitate [residue]	0.10
3. Metals of the platinum group—	
a Iridium, ruthenium, osmium, rhodium, and palladium, in a pure state.	
b Precipitated.	

Various articles manufactured of platinum and used in the laboratory of the mint, such as crucibles, spatulas, spoons, wire and retorts, were also shown.

Platinum occurs at many places in the gold region of the Urals, but principally at Nijne-Taguilsk, and in the district of Goroblagodat. The mines of Demidoff are at Taguilsk. The production of this metal up to the year 1834, according to M. Tegoborski, amounted to 103 poods and 24 livres, and the annual production was afterwards increased, but in 1847 it had diminished to 18 livres, 92 zolotniks, representing a value of 2,250 roubles. Tchevkine and Ozersky estimate that since the discovery of the metal in 1824 up to the year 1851, there had been 2,061 poods produced, of which 1,990 poods came from Nijne-Taguilsk alone, and 32 poods from Goroblagodat, and the remainder from the different gold washings of the Urals.[1] The official information furnished at the Exposition shows that the production has greatly diminished since the government ceased to use the metal for coins, and that the annual production now varies from 30 to 140 poods. The following is the production for the years named:

	Poods.		Poods.
1860	60	1862	142
1861	105	1863	30

This is an average of about 44,390 troy ounces, or 3,700 pounds troy per annum.

The *pépite* shown in the Demidoff collection is not the largest that has been found. One has been obtained weighing 16 pounds, and another nearly 23 pounds. Many of the nuggets shown at the Exposition possessed polarity in a high degree, and were so highly magnetic as to attract and hold iron filings like magnetic iron ore. This metal was formerly coined by the Russian government into pieces of 11 and 22 roubles each, and the amount coined from 1826 to 1844 equalled $2,500,000.[2]

CALIFORNIA AND OREGON.

Grains and scales of platinum and the associate metals occur sparingly with the gold in almost all parts of the California gold field, but they are most abundant in the northern mines. At Port Orford and its vicinity, on the coast, these metals constitute a very large part of the product of the washing of the black sand of the beach for gold. The metals cannot be separated by washing, and the gold is extracted by the aid of quicksilver. The residue consists of minute scales and grains of platinum and platin-iridium, most of which are lifted by a magnet. This mixture was first brought from California by the writer in 1854, and an analysis

[1] *Vide* Dalloz, ii, pp. 360, 361.

[2] Dana's System of Mineralogy, p. 13.

of it by Mr. Charles A. Kurlbaum, jr., in Dr. Genth's laboratory, showed it to have the following composition:[1]

Insoluble in aqua regia, osmiridium	48.77	Gold	1.38
Platinum	43.54	Silver	0.13
Iridium	0.60	Copper	0.28
Rhodium	0.28	Lead	0.03
Palladium	0.49	Iron	4.52

GREAT BRITAIN.

Although this country does not produce platinum and the associate rare metals, the honor of working them into the most perfect and largest vessels for economical uses must be given to its artisans. The most prominent and interesting display of the precious metals, including platina in its raw and manufactured state, at the Exhibition, was made by the firm of Johnson, Matthey & Co., of Hatton Garden, London. The various objects exhibited are enumerated in the following descriptive list prepared from the data given in the circular furnished by the firm:

PLATINUM APPARATUS.

Platinum stills and syphons.—One still to concentrate 8 tons (8,000 kilograms) of sulphuric acid per day. Value £2,500, (62,500 francs.)

One still to concentrate 5 tons (5,000 kilograms,) of sulphuric acid per day. Value £1,640, (41,000 francs.)

These stills comprise several new improvements, the most remarkable of which is that they are made without gold-soldered joints, so that the whole boiler is formed, so to say, of but one solid piece of metal. This is effected by autogenous soldering, which important improvement not only renders these vessels stronger, more durable, less liable to leakage and want of repair, and less costly than those made upon the old plan, but also enables the gauge of the metal to be regulated in accordance with the wear and tear to which the different portions of the still are exposed, saving unnecessary weight of metal where thickness is not required. These magnificent specimens of autogenous soldering deserved a minute and careful examination. The metal of which these boilers are manufactured is of absolute chemical purity.

Platinum syphons.—The improvements shown were of considerable importance. By means of the ball and socket joint the tubes can be adjusted to any required angle, and can be removed with facility. The platinized bronze clamps formerly used, which constantly required renewal, are entirely dispensed with. To facilitate packing and cleaning, the branch tubes are also made with double joints in the middle.

Improved platinum syphon.—For use in gold and silver refineries.

Platinum alembic.—For use in mints, refineries, and chemical manufactories; generally employed for the separation of gold and silver, but so constructed as to be capable of adaptation to all ordinary purposes. Value £300, (7,500 francs.) By the use of such an apparatus not only

[1] Report of a Geological Reconnaissance of California, p. 300.

is great economy and rapidity effected in refining, but this operation is conducted with much greater certainty and safety.

Platinum still-head and arm—Of a new shape for sulphuric acid boilers. By this simple alteration an immense saving is obtained, the production of concentrated acid is increased, and the weak acid which is condensed in the leaden worm is reduced in strength 30 per cent.

Platinum distilling apparatus and tube.

Platinum ingot—Prepared of chemically pure metal and forged in one mass. Value £1,100, (27,500 francs.) With such an ingot a whole body of a 5-ton boiler (such as was shown) can be manufactured.

Model of an ingot—Of pure platinum melted by Messrs. Johnson, Matthey & Co., by the heat of the compound blowpipe. Weight 3,250 ounces, (100 kilos.) Value, £3,400, (85,000 francs.) This enormous ingot was melted for the Exhibition of 1862, where it was exhibited for six months.

Pure platinum melted—By the intense heat of the compound blowpipe. Three ingots, value, £540, (13,000 francs.)

Platinum tubes.—These tubes are made of every length and size, and autogenously soldered. In strength and durability they are superior to those made with gold solder, and also to those made by pressure, as they escape the severe strain which the thick metal, of which pressed tubes are necessarily made, must undergo.

Platinum steam coil—Made of pure platinum tubing autogenously soldered. Value, £800, (20,000 francs.) Manufactured for Messrs. Crosse & Blackwell, and used by them for boiling their pickling vinegar. The length of the tube was about 32 feet, (9.660 metres,) diameter 1½ inches (4 centimetres.) They also exhibited an aluminium steam pan for boiling preserves.

Platinum wire—Sheet, foil, gauze, crucibles, capsules, dishes, pans, lightning conductors, &c., &c.

Platinum plate—Soft, half-hard, and hard.

Platinum assay apparatus—By the use of which gold assays can be made with the greatest accuracy and rapidity.

Iridio-platinum—(Matthey's alloy,) expressly prepared for vents or bushes for heavy ordnance. One vent, loaned by Mr. Whitworth, was exhibited in section. It has fired 3,000 rounds from a Whitworth cannon, and scarcely shows wear.

Platinum in various forms—Native, sponge, alloy, salts, plated on copper and on silver, for scale pans and philosophical instruments. Platinum granulated and alloyed with iridium, 10, 15, and 20 per cent.

RARE METALS AND COMPOUNDS.

Precious and rare metals—In the native state and in prepared forms. These formed a series of cylinders weighing one kilogram each (about

two pounds) of the following noble, rare, and common metals of chemical purity and cast in a symmetrical form to demonstrate to the eye their respective specific gravity and their characteristic qualities when cast: Gold, silver, platinum, iridium, rhodium, osmium, palladium, lead, bismuth, copper, cadmium, cobalt, nickel, iron, antimony, zinc, magnesium, aluminium, thallium, sodium, mercury.

Samples and preparations of rare metals, and of the non-metallic elements, boron and silicon.

Sodium amalgam—As used (under the patents of W. Crookes, esq. F. R. S.) for the extraction of gold and silver from their ores.

Magnesium in ingots, plates, bands, rods, wire, ribbon, lamps, &c.

Chemical and metallurgical products.—Nitrate silver, in all commercial forms, chloride of gold, salts of platinum, iridium, rhodium, palladium, gold, silver, copper, cobalt, cadmium, lead, antimony, arsenic, mercury, nickel, tin, zinc, &c.

A series of the salts of uranium.—New colors for enamel painting, chromo-lithography, and decoration, manufactured by an entirely new process, by means of which great brilliancy, durability, and harmlessness are insured at a less cost than that of ordinary colors.

A series of native gold specimens, nuggets and dust from various parts of the world, illustrating their various characteristics and natural forms.

A series illustrating the two processes of refining the precious metals, and preparing them for coinage and for manufacturing purposes, showing the various crude forms in which they reach England; the metals and their solutions; the various stages of the refining and melting processes. Also the secondary products—the pure salts and metals, and the condition in which they are delivered over for coinage and other purposes.

The total value of the whole series was estimated at £20,000, or about $100,000.

The large platinum stills are nearly four feet in diameter, and they are splendid specimens of the art of working this metal, which is now based upon the production of large homogeneous ingots by fusion before the oxyhydrogen blowpipe. It is stated by the exhibitors that the ingots, which are about as large as common bricks, were melted according to the method of St. Claire Deville and Debray. This method is one of the direct gifts of science to the arts, and was first proposed by Dr. Hare of Philadelphia, who, in 1837, melted 28 ounces of platinum into one malleable homogeneous mass.

The platinum assay apparatus appears to be a great improvement over the apparatus in ordinary use, and it is said to give more exact results.

It consists of two shallow kettles of platinum, about a foot across the top, set in holes, in a platform, like those in the top of a stove, so that heat from a gas-lamp can be applied below. The nitric acid for dissolving the silver out of the assays is placed in these kettles and heated. A frame of platinum made to fit the interior of the kettles is divided by thin partitions into 200 or more little compartments, into each of which

a little platinum cup is placed. These cups are about as large as a child's thimble, and are intended to hold the assay. They are made so as to be easily taken out or replaced in the frame, and the bottom is pierced with fine slits at right angles, so that the hot acid can enter when they are lowered with the frame into the kettle, and so that the acid may drain out when the frame, with contents, is raised. By means of this apparatus the pouring off of acid and the separate washing of each assay is avoided. It has been in use for five years in the laboratory of the firm with complete success. The whole apparatus, with two kettles, is about two feet long and 13 inches wide. A porcelain hood covers the kettles and condenses the acid vapors, discharging them into a vessel at one side.

The same firm exhibited a block of pure magnesium, weighing five kilograms, about 11 pounds. The metal was also shown in large quantities in the shape of foil for galvanic batteries, ribbons for showing the magnesium light, and in coils of wire of various sizes.

Iridium, osmium, and other rare metals.—This display of the rare metals was the most complete that has ever been made, both in number and in quantity. Some of the rarest elements which are seldom seen, even in small grains, were here shown in massive ingots. A bar of platin-iridium, nearly three inches long, was solid, compact, and homogeneous. This is the second which has been made, and it was formed by melting up small grains not much larger than the tips of a gold pen. This alloy has been made by Mr. Matthey for the vents or bushes for heavy ordnance, for which it is peculiarly fitted by its great hardness and indestructibility.

The bar of osmium presents a totally different appearance from the iridium, and resembles a mass of ordinary coke. Ruthenium is the only one of these extremely rare metals which is shown in small quantity, being represented by a few masses about the size of peas.

In the series of metals cast in rods, weighing one kilogram each, for the purpose of showing their bulk relatively to their weight, the metals which oxidize rapidly on exposure to the air, and quicksilver, which is fluid at ordinary temperatures, are confined in glass tubes. These tubes have the same internal diameter as all the rods of the series—about one inch.

The platinum cylinder is about four inches long; the quicksilver about seven inches; and the others elongate by a very regular gradation up to the metal aluminium, which towers two feet above the metal which precedes it, and is in its turn overtopped by the rod of magnesium, which is nearly four feet long—about twelve times longer than the platinum cylinder of the same weight.

The firm which made these interesting and instructive exhibitions received three medals, two of gold and one of silver, as follows:

"For progress in metallurgy and refining the precious metals," a gold medal.

"For improvements in the construction and manufacture of platinum

sulphuric acid stills and apparatus, and for perfection in working the precious metals," a gold medal.

"For nitrate of silver, chloride of gold, and chemical and metallurgical preparations," a silver medal.

QUICKSILVER OF SPAIN AND CALIFORNIA.

In the mineral exhibition made by Spain there was a series of large and splendid specimens of cinnabar and of native quicksilver, which fully illustrated the celebrated mine of Almaden. This was by far the finest display of quicksilver and its ores in the Exposition, and was calculated to impress all who saw it with the superior richness of the mine. The ore is not so brilliant and high-colored as the cinnabar of the New Almaden mine, in California; it is brownish and brick-red, looking more like peroxide of iron. The Almaden has been worked since three centuries before the Christian era, and it produces from 20,000 to 22,000 Spanish quintals (2,000,000 pounds to 2,235,000 pounds) of quicksilver annually. The statistics for 1862-'63 show that 113,266 metric quintals of ore were extracted, and that 2,443 workmen were employed.

The collections from the Pacific coast contained suites of specimens from the New Almaden mine; the New Idria, in Fresno county; and from other localities in California, and several interesting specimens from a new locality in Idaho. These last consisted of carbonate of lime—limestone—with disseminated patches and nodules of cinnabar of great purity and high color. Quartz is not present. Carbonate of lime appears to be as much the gangue or vein stone of cinnabar, as quartz is of gold. The following data upon the present production and export of quicksilver in California are from the Mercantile Gazette and Annual Review for 1867:

"With the opening of new mines and the extension of those already opened, the capacity for the production of this metal in California is being rapidly enlarged. In fact, enough could easily be turned out here to supply the requirements of the whole world without severely taxing the energies of the mines now being worked or in course of development. In fact, it is the question of a market rather than the supply of ore that most concerns the owners of these properties; and since this is an article of limited use, being restricted to a few specific purposes, the consumption is not, like many other commodities, greatly affected by the price. With the extension of mining operations and the arts of civilized life, there must, of course, be a corresponding increase in the demand for this metal, yet these are slow and inconsiderable compared with the rapid increase in the power for producing it that is going on in this State.

"The New Almaden mine, which has now been worked nearly 18 years, with a steady increase of productive power, when worked to its full capacity, is still turning out at the rate of over 30,000 flasks annually, the ore deposits being abundant, with large reserves extracted and retained for reduction when the demand may call for it. The total yield

of this mine since it was first opened approximates half a million flasks, worth, at the lowest calculation, $20,000,000. This company has a capital of $10,000,000, employ a force of about 1,200 hands, and are subject to an average yearly expenditure of over $700,000. About one year ago the company made large additions to their reduction works, increasing their capacity and introducing many valuable improvements, whereby they have been enabled to treat with profit a lower grade ore than before. The New Idria mine, situated on the easterly slope of the coast range, in the western part of Fresno county, after having been restrained from being worked for several years through legal proceedings, resumed operations over a year ago, since which time it has been worked vigorously, and with success, nearly 300 hands having been employed, and the ore yielding about the same per cent. of metal as that from the New Almaden mine. About 12,000 flasks of quicksilver are turned out at this mine annually, and the ore deposits are represented as looking extremely favorable. At the Chapman or San Juan Bautista mine, recently opened on Chapman's ranch, three and a half miles south of San José, furnaces have been erected capable of reducing 17,000 pounds of quicksilver per month. About 1,000 tons of ore have been raised, which yields at the rate of 10 per cent. of metal, and the deposit in the mine appears to be large. This mine is turning out about 300 flasks of metal per month, a rate of production that it is thought can be kept up and perhaps largely increased. The Redington mine, situate in Lake county, about 50 miles north of Suisun City, employs 200 men, and is turning out about 1,000 flasks of quicksilver monthly. Extensive improvements have been made at this place, and it is considered a valuable property, as the deposits are extensive and the ore of fair grade, while the facilities for insuring economical reduction are many. In Pope valley, Napa county, a valuable deposit of quicksilver has been developed within the past year. Quite recently furnaces having a capacity for reducing eight tons of ore daily, with other works, have been erected at this place, all of which, should first trials warrant, will be largely added to the ensuing spring.

* * * * * * * * *

"The three year contract purchase expires in April next; during its existence the product of the State has been largely increased, not only by the companies interested, but by the resumption of the New Idria Company, long closed by an injunction issued out of our courts. At present the monthly production of the New Almaden Company is placed at 2,500 flasks—Redington Company upwards of 1,000. The Chapman Company is largely owned and controlled by same stockholders, will soon produce 300 flasks monthly; besides these, the product of the New Idria and the Guadalupe, and others about commencing operations, must be added; it is safe to place the total monthly production of the State at upwards of 4,000 flasks, or say 50,000 in 1868. Of the entire product of the State since the first opening of the mines we have no reliable data as to quantity. Our first exports of which we have any knowledge

were in 1852, when 900 flasks were shipped abroad; in 1853, 12,737 flasks; increasing rapidly until 1859, when government took possession of the New Almaden mine, then the exports declined in that year to 3,399 flasks as against 24,142 the year previous. In 1860 but 9,448 flasks were exported, but in the year following work was again resumed at the mine, and shipments at once increased to about 36,000 flasks, and have continued to this date upon a liberal scale, so that for a period of 15 years we have sent abroad about 390,000 flasks, of the approximate value of $16,000,000. The present stock in the State is upwards of 10,000 flasks. The export price during the continuance of the three-year monopoly was, we believe, uniformly 55 cents, and for local use 60 cents per pound. The contracting parties referred to have themselves been large exporters during the entire period of their contract, and have, to a considerable extent, had the monopoly of the markets of the world—at least those available to us—and when any disposition was shown by outsiders to purchase for export, the proposed destination was required before naming the price—hence the difficulty for months past of giving any reliable market quotation. The companies, books, and operations generally, as well as actual products of the mines, have all been closed to the outside world during the entire contract period of three years. What is to be the future of the market we know not, but from present indications prices are likely to rule low, chiefly for the want of an outlet commensurate with the increased product of the State. The local consumption of the coast has been computed at about one-third of the average production. In regard to the Redington Quicksilver Company, no new facts of general interest have transpired since last year. Two hundred men are now employed; the production for the incoming year estimated at 1,000 flasks per month—if ore should improve it will be larger; with ore of present grade and with present capacity of works and force employed will produce somewhat over 1,000 flasks monthly, while by enlarging works and increasing number of hands, could, with present class of ores, produce much more, but it is no object to do so at present prices, or rather limited consumption, for the real trouble is want of an enlarged market. Deposits of ore in this mine are no doubt extensive, and thus far have proved of fair grade. Facilities for working the mines and reducing the ores are good, with railroad transportation, of which there is a prospect at an early day, the cost of shipment to market will be materially reduced."

The following are the receipts of quicksilver in San Francisco for each month during three years to 1868, and the sum total thereof as far as can be ascertained. These receipts came over the San Francisco and San José railroad, and include the New Almaden, New Idria, and Chapman mines. The parties interested in other mines withheld their figures for reasons best known to themselves, but those given are a fair criterion of the product of this metal during 1867. The receipts were as follows:

Production of quicksilver in California.

	1865.	1866.	1867.
	Flasks.	*Flasks.*	*Flasks.*
In January	3,768	4,524	2,342
In February	3,512	3,684	711
In March	3,427	4,557	987
In April	4,050	2,536	9,727
In May	4,501	2,877	6,117
In June	4,000	3,415	2,699
In July	3,710	3,830	1,611
In August	4,500	3,779	988
In September	4,606	3,491	2,242
In October	3,010	4,080	6,014
In November	3,839	2,221	4,134
In December	4,271	1,731	1,531
Totals	47,194	40,725	39,103

In addition to the above, the Redington Company produced on an average about 1,000 flasks per month, which would increase the receipts for 1867 to 51,103 flasks.

The exports to the different countries for 1867, and the previous three years, were as follows:

Exports of quicksilver, 1864–1867.

	1864.	1865.	1866.	1867.
New York	1,495	6,800	3,800	2,900
Great Britain	1,609	10,400	3,000	1,500
China	18,908	14,248	10,252	10,011
Mexico	7,483	2,789	9,561	10,042
South America	7,974	7,500	3,000	3,800
Australia	100	200	575	300
British Columbia	21	24	6	20
Other countries	337	508	93	280
Total flasks	36,927	42,469	30,287	28,853

And the exports previously have been:

	Flasks.		*Flasks.*
In 1863	26,014	In 1857	27,262
In 1862	33,747	In 1856	23,740
In 1861	35,995	In 1855	27,165
In 1860	9,448	In 1854	20,963
In 1859	3,399	In 1853	12,737
In 1858	24,142	In 1852	900

Each flask contains about 75 pounds of metal.

PRODUCTION AND CONSUMPTION OF GOLD AND SILVER.

CHAPTER VIII.

AGGREGATE PRODUCTION OF THE PRECIOUS METALS.

DIFFICULTY OF OBTAINING STATISTICS FOR EARLY PERIODS—ESTIMATES BY JACOB AND OTHERS—HUMBOLDT'S ESTIMATES AND STATISTICS FOR THE PERIOD FROM 1492 TO 1803—DANSON'S STATEMENTS OF PRODUCTION IN MEXICO AND SOUTH AMERICA—RÉSUMÉ OF PRODUCTION TO 1803—PERIOD FROM 1803 TO 1848—PRODUCE OF AMERICAN AND OF EUROPEAN MINES—PERIOD FROM 1848 TO 1868—MAXIMUM YIELD IN 1853—PRODUCTION AT THE PRESENT TIME OF GOLD AND SILVER—SILVER PRODUCT INCREASING WHILE GOLD IS DECREASING—ESTIMATES BY NEWMARCH OF MEAN ANNUAL PRODUCTION—TABLE OF AGGREGATE PRODUCTION FOR TWENTY YEARS—SUMMARY.

ESTIMATES OF PRODUCTION TO 1803.

In this chapter the attempt is made to present a résumé of the aggregate amount of gold and silver added to the stock of the world in historic times, and to show the production and consumption of the precious metals at the present time, based upon the statistics given in the foregoing pages and other sources, in order to show approximately the present annual production of the precious metals, and to compare this production with that of other periods. In regard to the general estimates of aggregate production, and especially in regard to those anterior to the 16th century, it is necessary to premise that precision is impossible. Statistics are not attainable, and the field is open for conjecture. Jacob, who in 1831 published his Historical Inquiry into the Production and Consumption of the Precious Metals, has attempted to give a connected view of the production of the precious metals from the most remote ages to the discovery of America and onward to the date of his publication. Without assuming the correctness of these estimates it may be well, in the absence of any others, to present a brief view of them as an introduction to the more precise and certain data given to us by Humboldt and other writers for the period from the discovery of America to the commencement of this century.[1]

[1] McCulloch in his article upon the precious metals, (Encyclopedia Britannica, 1859,) says that the difficulty of investigation of the production and consumption of the precious metals "is at least as great as their importance. They are not in truth of a kind to afford any certain conclusions, and we must be contented with those that seem to present on the whole the greatest amount of probability." He does not think that any reliance can be placed upon the accuracy of the estimates made by Jacob and others upon the production during early periods.

Jacob assumes as a basis of an estimate that the quantity of money in existence at the time of Augustus was about £358,000,000. He estimates the loss of gold and silver by wearing to be at the rate of one part in 360 annually, so that a gold or silver coin weighing 360 grains would lose a grain in weight yearly, or a 36th part in 10 years, and upon this supposition he presents a table showing the decrease in the quantity of gold and silver money in the Roman empire between the death of Augustus, in the year 14, and the termination of the western empire, in the years between 470 and 490, and extends the same hypothetical calculation to the year 806. By this constant deduction of 10 per cent. for wear at the end of each period of 36 years, he reduces the entire amount to about £35,000,000 in the year 800. But exception may justly be taken to this large allowance for loss by wearing while no addition is made for the accessions to the stock by mining during that period. Jacob himself says that the supplies from the mines of gold and silver had not wholly ceased in the reign of Augustus, but the products were trifling, and in the earlier years comprehended in his table had the effect of slightly lessening the decrease.

It is impossible to form more than a conjecture of the quantity of precious metals produced from the year 800 onward to 1492, the date of the discovery of America; but Jacob, who made a careful investigation upon this point also, was disposed to conclude, as far as any judgment could be formed from the few attainable facts, that the whole quantity yielded by the European mines during that period did not average more than about £100,000 annually, and that it certainly was not more than sufficient to supply the loss by waste and wear, and thus to keep the stock on hand about equal to what it was in the year 800. Calculation shows that the amount required upon this hypothesis is, for the 692 years, £69,200,000. It appears by these estimates, which, however, may be regarded as too low, that at the time of the discovery of America the quantity of the precious metals in existence in Christendom did not amount to more than about £35,000,000, and had been steadily decreasing for several centuries, or, at least, the annual supply was not more than sufficient to supply the waste. From that time there has been a continuous although variable increase. This increased production appears to have resulted not only from the influx of gold and silver from the New World, but also from the remarkable stimulus which these new discoveries gave to mining industry throughout Europe. Jacob says that "the discovery of America and of the mines it contained seems to have kindled a most vehement passion for exploring the bowels of the earth in search for gold in most of the countries of Europe." There was in fact a great mining excitement, and between the years 1538 and 1562 more than a thousand leases of mines were taken.

For the eight years from 1492 to 1500 Humboldt estimated that the average annual supply of the precious metals to Europe from America was about £52,000 sterling. The first large shipment of gold to Europe was by

Orando in 1502, and amounted to about £70,000 sterling in value, but the greater part of this was lost by the wrecking of the vessels in a great storm.

It is believed that the gold collected by the various explorers of America from the year 1500 to the invasion of Mexico by Cortez in 1519, may have equalled, but did not exceed, the amount which Humboldt estimated as the annual product between 1492 and 1800, or £52,000 sterling per annum.

When Cortez invaded Mexico he received presents from Montezuma equal to nearly £70,000 sterling in value, and the tribute paid must have amounted to £65,000 more. Bernal Diaz states that the plunder which fell into the hands of the Spaniards at the capture of Tenochtitlan was equivalent to £80,000.

Twenty years later Peru was invaded by Pizarro. Here, also, mines of the precious metals had long been wrought for the Incas, but the chief supply of silver appears to have been obtained from argentiferous lead. In 1545 the rich mines of Potosi were discovered, and this marks a new era in the production of silver. In 1630 the veins of Pasco were discovered, and those of Gualgayoc in 1771.

Taking Humboldt's estimate of an average annual production of £52,000, Jacob extends his calculations as follows: The increase in the production was—

From 1492 to 1521, 29 years, at £52,000	£1,308,000
Capture of Mexico (1521) to 1545, 25 years, at the annual rate, as estimated by Humboldt, of £630,000	15,750,000
Total addition in 63 years	17,058,000
Add stock on hand in 1492	33,674,256
Total to 1545	£50,732,256

From this period onward the annual average production in the Americas is estimated to have approached $10,000,000, or about £2,100,000. In Europe the production was enhanced to about £150,000 annually. At this rate of supply for 54 years, to 1600, the total amount was about £121,500,000. To this calculated amount, including the amount of about £50,000,000 on hand in 1545, he applies the same estimated reduction by wear, or one-tenth part in 36 years, and thus reduces the estimate of the stock of precious metals at the end of 1599 to about £155,000,000.[1]

In his succeeding estimates up to the beginning of this century, he places the amount on hand in Europe at that time, after deducting what had been sent to Asia, and what was supposed to have been used in the arts, at £130,000,000. In respect to the shipments of gold to Asia, and to the amounts which are deducted, he observes:

"In the absence of any precise facts, and with but little confidence in

[1] It will be noted that there is a discrepancy between this amount and that in the summary on page 204, which is there explained.

an approximation to accuracy, we may venture to suppose that the precious metals which passed from Europe to Asia in the 112 years, from the first discovery of America to the end of the 16th century, amounted to one-tenth of the whole quantity produced, or about £14,000,000; and we may further suppose that one-fifth of the gold and silver had been abstracted from its primary use as money and converted into other commodities, either for use or ornament."

This explanation will be sufficient to introduce the figures which follow, compiled from the estimates made by that author:[1]

Stock on hand in 1492			£34,000,000
Production 1493–1599 over loss and wear		£138,000,000	
Used in the arts	£28,000,000		
Sent to Asia	14,000,000		
Total deductions 1493–1599		42,000,000	
Net gain 1493–1599			96,000,000
Stock on hand at the end of 1599			130,000,000
Productions of XVIIth century		337,500,000	
Sent to Asia	£33,250,000		
Used in the arts	60,250,000		
Wear and loss	77,000,000		
Total deduction for XVIIth century		170,500,000	
Net gain of XVIIth century			167,000,000
Stock on hand at the end of 1699			297,000,000
Productions of 1700 to 1809		880,000,000	
Sent to Asia	£352,000,000		
Used in the arts	352,000,000		
Wear and loss	93,000,000		
Total deductions 1700 to 1809		797,000,000	
Net gain from 1700 to 1809			83,000,000
Stock on hand at the end of 1809			380,000,000
Production from 1810 to 1829		103,736,000	
Sent to Asia	£40,000,000		
Used in the arts	112,252,220		
Wear and loss	18,095,220		
Total deductions from 1810 to 1829		170,343,440	
Decrease from 1810 to 1829			66,611,440
Stock on hand at end of 1829			£313,388,560

[1] See "Historical Inquiry," &c., ii, pp. 70, 131, 214.

This tabular presentation up to 1809, and the statements which precede it, may be analyzed as follows:

Analysis of Jacob's estimates.

Period.	Amount on hand and production.	Loss and wear.	Used in arts.	Sent to Asia.
On hand in time of Augustus, year 14	£358,000,000			
Year 14 to 806		£324,000,000		
806 to 1492	[1]69,000,000	69,000,000		
1492 to 1599	[2]138,500,000	18,500,000	£28,000,000	£14,000,000
1600 to 1699	337,500,000	77,000,000	60,250,000	33,250,000
1700 to 1809	880,000,000	93,000,000	352,000,000	352,000,000
Total	£1,783,000,000	£581,500,000	£440,250,000	£399,250,000

The sum of these deductions thus made by Jacob is £1,421,000,000, and the total production, £1,783,000,000; or, in dollars, in round numbers, $8,915,000,000.

I have been thus particular in presenting these estimates by Jacob, in order that readers may form their own conclusions in respect to their accuracy or claims to adoption. It appears improbable that the loss by wear has been as great as Jacob assumes, and much more doubtful that the production of gold and silver utterly ceased during the period from the reign of Augustus to 800. It is more reasonable to believe that the supply was at least equal to the waste by loss and wear. Gold-digging is an occupation which may be followed in the most dark and troubled times, and by savage races, and as we have no reason to conclude that the purchasing power of the precious metals was impaired during that period, the usual inducement for their extraction from the earth remained.

HUMBOLDT'S STATISTICS.

For the statistics of the production of gold and silver in America from the discovery of the country to the year 1803, reliance is placed chiefly upon the celebrated work of Baron Humboldt, the "Political Essay upon the Kingdom of New Spain," in which, in addition to an account of the

[1] Jacob, in chap. xiv, page 361, assumes that the annual production of gold from 806 to 1492, a period of 690 years, was about £100,000 per year, and inasmuch as the amount in circulation at both periods was nearly the same, the production was only sufficient to compensate for the loss by wear; £69,000,000, therefore, represents both the production and loss.

[2] There is here a discrepancy in Jacob's statements. In the table, and the text from which it is taken, (ii, page 70,) he gives £138,000,000 as the production in that period, over and above the loss by wear. But the data he gives on pages 52, 53, and 62, show a production from 1492 to 1546 of

tion from 1492 to 1546 of	£17,058,000
1546 to 1599 of	121,500,000
Total	£138,558,000

And the statements of loss by wear on pages 54 and 63 amount to £18,482,000 on these amounts, including also the wear on the before existing £34,000,000. And he further states the amount on hand at the end of 1599 as about £155,000,000.

examinations of the mines made by him, all the available data relating to the subject of the production and export of the precious metals are brought together.

This eminent authority estimates that the annual average supplies of the precious metals derived from America were as follows:[1]

	Average per year.		Average per year.
From 1492 to 1500...	$250,000	From 1600 to 1700..	$16,000,000
From 1500 to 1545...	3,000,000	From 1700 to 1750..	25,500,000
From 1545 to 1600...	11,000,000	From 1750 to 1803..	35,300,000

In a recapitulation of the value of the gold and silver raised from the American mines from 1492 to 1803, he estimates the amount—

	Piastres.
Registered:	
From Spanish colonies	4,035,156,000
From Portuguese colonies	684,544,000
Not registered:	
From Spanish colonies	816,000,000
From Portuguese colonies	171,000,000
Total	5,706,700,000

These statements, and the tables in detail, by Baron Humboldt, upon which they are founded, have been carefully studied and compared by Mr. Danson, who finds reason to amend them. In an elaborate article published in 1851,[2] he reviews the subject, and presents the following amended statement, which reduces the total, as given by Baron Humboldt, by 138,506,000 piastres, or a little more than two per cent.

Amended statement.

Country.	Registered piastres.	Contraband piastres.
From New Spain, (gold and silver)	1,767,952,000	260,000,000
From Peru, viz: Potosi, Pasco, Gualgayoc, Huantajaya, &c., (silver)	1,769,698,000	434,000,000
From the Spanish colonies, &c., under New Spain, (gold)	332,000,000	82,000,000
From Brazil, (gold)	737,544,000	185,000,000
	4,607,194,000	961,000,000
	961,000,000	
Grand total, (piastres)	5,568,194,000	

Of this whole amount, 1,415,544,000 piastres (exchange at 4*s.* 3*d.*, £300,803,100) is supposed to have been gold, and 4,152,650,000 piastres

[1] Essai Sur La Nouvelle Espagne, iii, 428, 2d ed.

[2] "On the quantity of gold and silver supposed to have passed from America to Europe from the discovery of the former country to the present time, by J. T. Danson." Read before the Statistical Society of London, December 16, 1850, and published in the Journal, vol, xiv, 1851.

(£884,350,635) silver. But this does not show the amount of the precious metals taken to Europe. An allowance is to be made for the quantity retained in America, and for such portions as were exported to other countries than Europe. Humboldt estimated this down to 1803, at an annual average of 600,000 piastres. Danson observes that in Humboldt's estimates no allowance is made for wear and for the casual losses during the three centuries, and allowing for gold and silver together only one-fourth of one per cent. per annum, on a probable average of 50,000,000 piastres in use, he makes the total to be deducted 37,500,000 piastres, as shown in the following amended account, which he presents:

		Piastres.
Gold in use in America at the arrival of the Spaniards..		40,000,000
Gold and silver raised from the mines between 1492 and 1803		5,568,194,000
		5,608,194,000
1. Deduct the quantity probably consumed in America during the three centuries ended in 1803	Piastres. 37,500,000	
2. Also the quantity supposed to be remaining in America in 1803........	153,000,000	
3. And the quantity supposed to have been sent elsewhere than to Europe..........	133,000,000	
		323,500,000
Total value of both metals sent to Europe down to 1803..		5,284,694,000

or, sterling exchange at 4*s.* 3*d.*, £1,122,997,475.

Danson observes that this is apparently the best account that can be framed down to 1803.

Humboldt gives the following estimate of the production of the mines of the New World at the commencement of this century:[1]

Annual produce of the mines of America at the commencement of the nineteenth century.

Political divisions.	GOLD.		SILVER.		Value of gold and silver in dollars.
	Marcs of Castile.	Kilograms.	Marcs of Castile.	Kilograms.	
Viceroyalty of New Spain..............	7,000	1,609	2,338,220	537,512	$23,000,000
Viceroyalty of Peru....................	3,400	782	611,090	140,470	6,240,000
Captain Generalship of Chili..........	2,212	2,807	29,700	6,827	2,060,000
Viceroyalty of Buenos Ayres..........	2,200	506	481,830	110,764	4,850,000
Viceroyalty of New Granada..........	20,505	4,714	....	....	2,990,
Brazil....................................	29,900	6,573	....	....	4,360,
Total	75,217	17,291	3,460,840	795,581	$43,500,

[1] Cited by McCulloch Ency. Brit., xviii, 460.

He further estimated the production at that time of the European mines and those of northern Asia at about £1,000,000 in addition.[1]

Chevalier also, citing from Humboldt's New Spain, says that Humboldt calculated that the gold production of America, Europe and Asiatic Russia amounted to 15,800 kilograms,[2] (£2,180,400.) Chevalier considers it doubtful if the gold which the Christian nations drew from other sources, and especially from Africa, added a weight of 2,000 kilograms (£276,000) to this supply. He therefore estimated that 18,000 kilograms, valued at £2,484,000, or about $12,420,000, would cover the amount of gold which then reached the Christian nations.[3] By including the island of Borneo and several other localities in the Indian archipelago, he supposes that the amount of pure gold may have been about 24,000 kilograms, worth about £3,312,000.

Birkmyre places the amount of pure gold produced in America in 1801 at 46,331 pounds troy; in Europe and Northern Asia, (exclusive of China and Japan,) 4,916 pounds; total 51,247 pounds, equal to 55,910 pounds of British standard gold, and valued at £2,612,200.

It will thus be seen that these authorities concur in estimating the value of the production of gold at the commencement of this century at about $13,000,000, in round numbers, and this is the sum which has been adopted in the tabular statements.

It will be observed, also, in the table given from Humboldt, that the supply was derived chiefly from South America and Mexico. Gold was most abundantly produced in New Granada, Brazil and Chili, and silver in Mexico and Peru. The supply of silver at that period from America was about 800,000 kilograms, according to Humboldt, and in all, according to Chevalier, about 900,000 kilograms, valued at £7,965,000.

Phillips places it at 2,337,300 troy pounds, the value of which would be approximately in round numbers $35,000,000. Of this amount 61 per cent. was obtained from Mexico.

RÉSUMÉ OF PRODUCTION TO 1803.

If, for the sake of presenting a connected view of the accumulation of the precious metals, we adopt the figures given by Jacob for the amount on hand at the time of the discovery of America, and the revised estimates of the statistics given by Humboldt, the result may be considered as nearest approximation that can now be attained. The aggregate production of Europe for the period from 1492 to 1803 is also to be added. Here it may again be premised that we have to depend upon estimates rather than on statistics. We are not, however, entirely in the dark in respect to the yield of the mines for at least a portion of the time.

[1] McCulloch, estimating the dollar at 4*s.* 6*d.*, makes the total of the table equal to £9,666,000, and the total, including Europe and Asia, at £11,000,000 in round numbers.

[2] The kilogram of fine gold, by the terms of the law 7 Germinal, year 11, is equal to 3,444 francs 44 centimes, (£138.) See Chevalier, p. 54.

[3] Chevalier on Gold, Cobden's translation, pp. 54, 55.

Jacob, citing from Andre,[1] states that "the average product of the mines of Europe, including those of the Russian dominions in Asia, did not in the last 20 years of the 18th century amount to more gold than equal in value to £200,000, and silver equal to £600,000. Of this gold, more than one-half was yielded by the mines of Russia, which afforded none before the year 1704. Of the remainder, the greater portion was extracted from the Austrian dominions, and the remainder in various small quantities from Saxony, Prussia and Hanover." The *annual* production, during that period, was nearly as follows:

Russia	£150,000
Austria	200,000
Saxony	100,000
Prussia and Hanover	110,000
Other sources	40,000
Total	£600,000

It is observed that the mines of Germany, with the exception of those of Saxony, were very little worked or known until the end of the period from 800 to 1500, and that the time of the greatest yield was but a few years before the termination of that period, so that if the average annual quantity produced between 800 and 1500 be estimated at one-seventh or one-eighth of the average between 1780 and 1800, it cannot be far from the truth. If we accept £600,000 as the yield for the last 23 years of the period following the discovery, and assume an annual average of £100,000 for the remainder, we have a total of £42,500,000, or, in round numbers, $212,500,000, as the sum to be credited to Europe in the succeeding summary, no allowance being made for loss, or for the production of India, China, Japan and Central Asia.

Approximate production from 1492 *to* 1803.

North and South America	$5,608,194,000
Europe	212,500,000
Total	$5,820,694,000

PERIOD FROM 1803 TO 1848.

The production of gold remained nearly constant from year to year after 1800 until the mines of Russia and Siberia began to be more extensively worked from 1810 onwards. The production of silver had been increasing, but about this time (1809) the revolution commenced in Mexico, and the production of the mines was greatly diminished. Jacob estimates that it was lessened one-half, but this is considered by some as an exaggeration.

Danson, in the elaborate memoir before referred to, has carefully

[1] C. C. Andre, Neueste Zahlenstatistik, &c., Stuttgart, 1823. Jacob, i, 359.

investigated the statistical returns from both North and South America for this period of 45 years. He considers the most authentic existing materials to be the collection of returns elicited from British consuls resident in the mining countries of America, in reply to a circular issued by the minister of foreign affairs in 1830.[1] Reference is also made to the work of Duport.[2] The statistical tables which he presents of the production of the different countries have been referred to, and some of them given in the preceding pages of this report, as, for example, under Mexico, page 156. The general summary of these tables is given as follows:[3]

Both Americas; general summary of production 1804–'48.

	Silver.	Gold.
Mexico	$702,026,872	$84,920,225
Peru	216,485,527	31,566,898
Buenos Ayres	287,143,190	170,691,290
Chili[4]	38,555,205	99,963,316
Columbia	170,000	204,255,328
Brazil	....	95,000,000
Central America	....	9,000,000
United States	....	15,500,000
Total, dollars	$1,244,380,794	$710,897,057
Pounds sterling, at 4s. 2d	£259,245,995	£148,103,550

This gives a total value for the two metals of $1,955,277,581; in round numbers $1,955,000,000.[5]

There are no similar complete statistical summaries of the production of the precious metals in Europe and Asia during this period. The bulk of the product was, however, obtained from the Russian gold field, the yield of which increased rapidly from 1825 to 1848. (See pages 92, 93.) From the data there given the total value of the production from 1800 to 1848 may be set down at $200,000,000, in round numbers.

For the production of the European mines for the period of 45 years, (1803 to 1848,) I have been unable, after prolonged examination of authorities, to arrive at any very satisfactory conclusion. Hypothesis seems to have taken the place of statistics, and even the estimates which

[1] These returns were made public in two sets, one in 1832, Parliamentary Papers, No. 338, and the other in 1843, Parliamentary Papers, No. 476 of those years.

[2] De la production des Metaux precieux au Mexique, &c., par St. Clair Duport. 8vo., Paris, 1843.

[3] Danson, 1857, Jour. Stat. Soc. Lon., xiv, 43.

[4] Commissioner Wilson, in his report for the year 1867, calls attention to an error in Mr. Danson's tabular statement for Chili. It is stated that about $30,000,000 which should have been added to the silver product was inadvertently added to the gold; thus the figures for the gold should be $70,757,532, and for silver, $56,525,000.

[5] Mr. Danson supposes that of this amount £360,579,545 was sent to Europe. Adding £1,122,997,475, the quantity sent to Europe from 1492 to the end of 1803, and we have a total of £1,483,577,020.

have been made are so combined with the estimates and returns of the production of Russia, Asia, and America that it is impossible to separate them in a satisfactory manner.

Humboldt, as already shown, estimated the value of the annual produce of the European mines of Hungary, Saxony, and those of northern Asia, at the commencement of this century, at £1,000,000. By subtracting the produce of Russia from this total the remainder should represent, approximately, the production of Europe at that time. Taking for the Russian production the average of 392 kilograms, (*vide* page 92,) value £54,096, the result is £945,904; in dollars, at $5 to the pound, $4,729,520. This result accords closely with the following calculation for another period, 1810 to 1830:

Jacob says that a communication from Baron Humboldt to Poggendorf's Annalen, shows that "the annual produce of the precious metals in Europe and Asiatic Russia amounts to 25,500 marcs of gold and 292,000 marcs of silver, of which 76,500 of silver and 22,000 of gold were from the Russian empire. The value of this gold is about £720,000, and of the silver £530,000, being together £1,250,000 annually, or in the period of 20 years, from 1810 to 1829, £23,000,000."[1] [£25,000,000.] If from this total as corrected, in round numbers $125,000,000, we subtract the production of Russia for the same period, viz, $31,000,000 in value in round numbers, we obtain the sum of $94,000,000, or an average of about $4,700,000 a year for the production of Europe. The figures given by Phillips for the production of silver and gold in 1800 show an aggregate value of $3,000,000, in round numbers.

Birkmyre's table of production of gold and silver in the years 1846 and 1850, (Appendix D, Table XIV,) shows a value of £1,309,600 for Europe in 1846, or in dollars, $6,548,000 in round numbers.

Considering the foregoing data, I have assumed that the average annual value of the production in Europe from 1800 to 1848, 47 years, was $7,000,000,[2] showing a total value of $329,000,000, and with the addition of the produce of Russia, $529,000,000.

The total production for this period, (1803 to 1848,) without any allowance being made for loss, or for the yield of China and India, may be summed up approximately as follows:

Aggregate production from 1803 *to* 1848.

North and South America	$1,955,000,000
Russia	200,000,000
Europe	329,000,000
Total	$2,484,000,000

[1] Jacob, ii, p. 268.

[2] This is considerably above the present production as shown by the later statistics.

PRODUCTION FROM 1848 TO 1868.

At the time of the discovery of gold in California in 1848, the aggregate annual production of the metal including a nominal estimate of $10,000,000 for Asia, was not over $40,000,000. The rapid increase in the production from that time is well known. Three years later the Australian placers contributed to swell the amount, until in 1853 the aggregate annual production of gold reached its maximum, and was no less than $193,500,000 in value, as shown in the annexed tabular statement. From that time to the present the production has been steadily decreasing, although maintained in part by the discovery of one new region after another.

Production of gold and silver in 1853.

Country.	Gold.	Silver.	Total.
California and other portions of the United States[1]	$61,000,000		$61,000,000
Australia[2]	60,000,000		60,000,000
Russia and Siberia[3]	15,000,000	$700,000	15,700,000
Mexico and South America[4]	8,000,000	29,000,000	37,000,000
Europe,[5] (estimated)	1,500,000	7,300,000	8,800,000
Africa, (estimated)	1,000,000		1,000,000
Borneo and East Indies[6]	5,000,000		5,000,000
Japan and Central Asia[7]	5,000,000		5,000,000
Total	156,500,000	37,000,000	193,500,000

The production of silver may be considered to have been pretty uniformly maintained until the year 1860–'61, when the great Comstock lode and the other silver regions of Nevada were discovered. Since that time the annual production of silver has been increasing, and may now be valued at about $54,000,000, as shown in succeeding tabular statement.

This table shows approximately the production at the present time in the principal gold and silver regions of the globe. The statistics of the gold production have already been given on page 108, at the end of the section upon gold, but the totals are here repeated for convenience of reference and comparison with the silver production.

[1] I have here followed the returns for California for 1853, as given on page 20, viz., $54,965,000, in round numbers $55,000,000, and have added 10 per cent. The table given by Commissioner Browne makes the product for 1853, $57,330,000. Ten per cent. added to this would give a total of over $63,000,000. To the sum for California, $500,000 is added for other portions of the United States not there included.

[2] Ounces, 3,150,020, (page 80,) at $19.04 per ounce = $59,976,380, in round numbers $60,000,000. The table given by R. Brough Smyth, 1866, gives 2,676,315 ounces as the export for 1853; but some additions were to be made for a portion exported through New South Wales and other colonies.

[3] See pages 92 and 93 for gold and page 182 for silver.

[4] The silver production of South America is here estimated at $10,000,000, and for Mexico, $19,000,000.

[5] An estimate based on the returns on pages 177, 179, 181, 185 and other data.

[6] and [7] For these countries I have made a merely nominal estimate of $10,000,000 as the aggregate; it is probably far below the actual production. Of the production of silver little or nothing is known.

Approximate statement of the value of the production of gold and sil the principal gold and silver producing countries, 1867.

SOURCE OF PRODUCTION.	GOLD.		SILVER.		GOLD AND
	Value of product.	Ratio per cent.	Value of product.	Ratio per cent.	Total value of production.
United States:					
California	$25,000,000	....	....	....	$25,000,00
Nevada	6,000,000	....	$12,500,000	....	18,500,00
Oregon and Washington	3,000,000	....	....	....	3,000,00
Idaho	5,000,000	....	2,500,000	....	7,500,00
Montana	12,000,000	....	....	....	12,000,00
Arizona	500,000	....	....	....	500,00
New Mexico	300,000	....	....	....	300,00
Colorado	2,000,000	....	500,000	....	2,500,00
Utah, Appalachians, and other sources (estimate)	2,700,000	....	....	....	2,700,00
Total	56,500,000	43.23	15,500,000	28.70	72,000,00
British possessions	2,560,000	1.96	....	....	2,560,00
Mexico	1,000,000	.76	19,000,000	35.30	20,000,00
Central and South America	5,300,000	4.05	10,000,000	18.59	15,300,00
Australia	31,550,000	24.14	20,000	.04	31,570,00
New Zealand	6,000,000	4.59	....	....	6,000,00
Russia	15,500,000	11.87	700,000	1.30	16,200,00
Europe	1,370,000	1.06	8,600,000	15.97	9,970,00
Africa	900,000	.68			
Borneo and East Indies	5,000,000	3.83	....	....	10,900,00
China, Japan, and Central Asia	5,000,000	3.83			
Total	$130,680,000	100	$53,820,000	100	$184,500,00

The figures are given in round numbers, and are drawn from the tistics presented in detail in the preceding chapters, or are estim based upon the latest statistics and information that could be obtai The amount of production for each country is stated by value in dol not by weight, for nearly all the returns of production of North South America are made by value.

No effort has been made to isolate the value of the silver containe the native gold of California and other gold regions. From the that the returns of gold bullion are made by value, this is not essent

It will be observed that in stating the value of the silver produ Nevada $6,000,000, or about one-third of the total bullion yield, is co ered to be gold. The figures are the same as are given on page 57 the exception of those for Idaho. Later information from that Terri has authorized the conclusion that the silver product for 1867 was ne

[1] From the returns of the director of the United States mint and branches, it appear from 1841 to 1868, the amount of silver parted from gold of domestic productio $5,261,776.

$2,500,000 in value than $1,500,000. Of the aggregate of $56,500,000 now credited to the United States as gold bullion it is probable that from $500,000 to $1,000,000 should be entered under the head of silver, thus increasing the total of silver from $14,500,000 to $15,000,000 or $15,500,000, and diminishing the total for gold to an equal amount. As it was not possible to ascertain what portion of this estimated additional amount for silver should be credited to California, Montana, New Mexico, Utah, and other sources, the separation from the figures for the gold product has not been attempted.

The ratio of the value in each of the principal countries to the value of the total production is shown in separate columns.

It appears that the total annual production of gold and silver at the present time is approximately as follows:

Gold	$130,680,000	70.83 per cent.
Silver	53,820,000	29.17 per cent.
Total	$184,500,000	100 per cent.

Of this total, 39.02 per cent. is produced within the limits of the United States; and of the gold, California and the other gold-producing regions of the country furnished 43.23 per cent.; Australia, 24.14 per cent.; and Russia, 11.87 per cent.[1]

At the commencement of this century the total gold production exclusive of Asia was less than $13,000,000; in 1847 it was about $41,000,000; and in 1853, $156,500,000.

Of the present production of silver the United States supplies about 9 per cent.; Mexico, 35.

The production of silver in the great silver region of the United States may be regarded as only commenced. Most of the silver has hitherto been taken from the Comstock lode, but when by means of railroads the other rich silver districts of Nevada are made more accessible for machinery, supplies, and labor, the total product of the State will be greatly increased, and, together with the opening of the many veins of Idaho, Arizona, Utah, and California, the product of silver bullion will probably soon equal if it does not exceed that of Mexico at any period of its history.

The total annual silver product of the world at the commencement of this century was about $36,000,000 in value, and as the gold product at that time was about $13,000,000, the ratio of the production of the two metals was as 36 to 13, being the reverse of the existing ratio, as will be seen by the following comparison, in per cents, of the total production at the two periods:[2]

[1] In summing up the percentages on page 108, the fractions were not correctly given. A slight change was made in the table in the proof, and the changes required in the fractions in the text were overlooked.

[2] Some details upon the relative values of gold and silver at different periods will be found at the end of the report.

Ratio of the production of silver and gold.

	1800.		1867.	
	Amount.	Per cent.	Amount.	Per cent.
Silver	$36,000,000	73.47	$53,820,000	29.17
Gold	[illegible]	26.53	130,680,000	70.83
Total	$49,000,000	100	$184,500,000	100

The diagram which accompanies this report will assist in making the gradual change in the product of gold and silver more evident. The profile line which shows the production of gold exhibits in a striking manner the rapid increase of the production up to 1854, and its present rapid decline.

AGGREGATE PRODUCTION TO 1868.

Having now shown as far as possible the annual production in 1848, in 1853, and in 1867, of both gold and silver, the calculations of the total accumulation of the precious metals up to the present time may be resumed.

Before giving the tabular statement which has been prepared, the following estimates by Mr. Newmarch, embodied by him in a letter to the French commission,[1] are presented together with an abstract of his observations in explanation.

He says that it is impossible to give exact figures, but he was disposed to regard the statement as the nearest approximation to the truth that could be reached.

Total mean annual production of gold and silver during the fifteen years from 1849 *to* 1863. *Table in millions of pounds sterling*, (13.5=£13,500,000.)

Number of years.	Period of production.	Gold annually produced.			Silver annually produced.	Total amoun't of gold.		Total of silver.
		Old sources.	New sources.	Total.		Old sources.	New sources.	
3	1849 to 1851	£13.5	£10.3	£23.9	£15.5	£40.5	£30.9	£46.5
5	1852 to 1856	14.0	24.7	38.7	16.1	70.0	123.5	80.5
3	1857 to 1859	14.6	21.9	36.5	17.1	43.8	65.7	51.3
4	1860 to 1863	15.3	18.3	33.5	18.2	61.2	73.2	72.8
15	Totals	......	......	......	......	215.5	293.3	251.1
	Averages	14.3	19.5	33.8	16.7	......	......	......

[1] In volume 5 of "Enquête sur les principes et les faits généraux qui régissent la circulation monétaire et fiduciaire," p. 538.

According to these figures the quantity of gold produced annually since 1856 from new sources has diminished nearly 13 per cent., and the quantity of silver has increased nearly 12 per cent. He estimated that the total quantity of gold from the modern sources was distributed approximately as follows:

	Sterling.	
Great Britain	£60,000,000	
France	110,000,000	
United States	50,000,000	
		£220,000,000
Australia	30,000,000	
California	20,000,000	
Turkey and the East	40,000,000	
Brazil, Egypt, Spain, &c	40,000,000	
		130,000,000
Total		£350,000,000

A summary of the statistics which I have collected, and the estimates which I have made upon the total production in the 20 years, from 1848 to 1868, inclusive, are given in the annexed table. The figures have been drawn as far as possible from the returns printed in the foregoing pages, and where estimates have been made they are based on actual returns for certain years or periods, and explanations are given in the foot-notes attached to the table. The returns from the principal gold-producing countries, California and Australia, are very complete and satisfactory, compared with those from Europe, with the exception of Russia. It is extremely difficult to obtain connected statistics of the production of Spain, Italy, Saxony, and Austria.[1] The figures must be received as approximations, as nearly correct as it is possible to obtain them. They show a total for the 20 years of—

Gold	\$2,757,600,000
Silver	813,400,000
Total	\$3,571,000,000

[1] It may here be observed in explanation of the absence of many statistics that should have appeared in these pages in order to render the work as complete as the author desires, that the time originally allowed for the preparation of the report (three months) was not sufficient to permit many important official publications to be obtained or consulted.

Approximate statement of the aggregate production of the precious metals, from 1848 to 1868.

COUNTRY.	GOLD. Value of production.	GOLD. Totals.	GOLD. Per ct.	SILVER. Value of production.	SILVER. Totals.	SILVER. Per ct.
NORTH AMERICA.						
California & ne'boring States[1]	$861,550,000			$10,000,000		
Montana[2]	71,500,000			500,000		
Colorado[3]	29,500,000			500,000		
New Mexico and Appalachians[4]	9,000,000			1,000,000		
Nevada[5]	28,450,000			61,000,000		
		$1,000,000,000	36.26		$73,000,000	8.97
British Columbia	20,000,000					
Nova Scotia	2,500,000					
Canada	100,000					
		22,600,000	.82			
Mexico		20,000,000	.72		380,000,000	46.71
SOUTH AMERICA.						
Chili	12,000,000			70,000,000		
Peru	10,000,000			70,000,000		
Bolivia	6,000,000			50,000,000		
Brazil	30,000,000			1,000,000		
New Granada	30,000,000			4,000,000		
Central America	4,000,000			5,000,000		
		92,000,000	3.33		200,000,000	24.5[illegible]
AUSTRALIA.						
Victoria	760,000,000			20,000		
New South Wales	85,000,000					
South Australia and Tasmania, Queensland	3,000,000					
		848,000,000	30.75		20,000	.02
New Zealand		48,000,000	1.75			
RUSSIA AND EUROPE.						
Russia[6] and Siberia	308,000,000			14,000,000		
Austria	16,000,000			44,000,000		
Norway				5,000,000		
Spain and rest of Europe	3,000,000			97,380,000		
		327,000,000	11.86		160,380,000	19.72
Africa	200,000,000					
Asia	200,000,000					
		400,000,000	14.51			
Totals		$2,757,600,000	100		$813,400,000	100

[1] From the sum total of California and the Pacific States, viz: $961,000,000, (p. 21,) I have deducted the total bullion product of Nevada, viz: $89,450,000—gold, $28,450,000; silver, $61,000,000, and have also deducted an estimated amount of $9,000,000 for Idaho silver, and $1,000,000 to cover silver produced in California, Arizona, and elsewhere.

[2] For Montana I have followed the estimate given by W. S. Keyes. (See p. 40.) Deducting $100,000, and regarding $500,000 of the amount as silver.

[3] Colorado. This is in part an estimate. (See p. 46.) Of the total of $30,000,000, $500,000 has been regarded as silver.

[4] New Mexico, Appalachians, and other sources. It is difficult to ascertain the amount of gold produced from the southern States; but this is an estimate based on the mint returns. A small amount of silver has been extracted from argentiferous lead and from the copper veins of Lake Superior. From this last source $209,[illegible] in value was deposited in the mint up to June, 1868.

[5] Nevada. This amount includes the gold contained in Comstock bullion, with a nominal addition for other sources.

[6] To the total production, according to the table (p. 93) for 1848 to 1864, an estimated amount of $[illegible] is added for the four years 1868, this being based on the annual average of $15,335,088. (See p. 93.)

Summary of aggregate production of gold and silver up to 1868.

14 to 800, (amount supposed to be on hand)	$1,790,000,000
800 to 1492	345,000,000
1492 to 1803	5,820,700,000
1803 to 1848, (p. 210)	2,484,000,000
1848 to 1868	3,571,000,000
Grand total	$14,010,700,000

This total, as already explained, is at best only an approximation, and is exclusive of the production of Asia, except a nominal allowance of $10,000,000 per annum for the last 20 years, and, with one or two exceptions, is without any allowance for loss in transportation or by wearing.

The first item includes what was supposed to be on hand in the time of Augustus (*vide* pages 201 and 204) and does not include any allowance for the production during the period, of which, in reality, nothing definite or satisfactory is known.

CHAPTER IX.

CONSUMPTION AND MOVEMENT OF THE PRECIOUS METALS.

ESTIMATE OF THE AMOUNT OF GOLD AND SILVER IN CIRCULATION IN VARIOUS COUNTRIES—ESTIMATES OF THE AMOUNT OF GOLD AND SILVER IN THE UNITED STATES AT DIFFERENT PERIODS—COINAGE OF ENGLAND, FRANCE, AND OTHER COUNTRIES—COINAGE OF THE UNITED STATES—USE IN THE ARTS AND LOSS BY WEARING—CURRENT OF THE PRECIOUS METALS—EXPORTATION TO INDIA—DECREASE IN THE PRODUCTION OF GOLD—PRODUCTION OF GOLD FROM PLACERS AND FROM VEINS COMPARED—PROBABLE RISE IN THE VALUE OF GOLD—MEANS OF PROMOTING THE PRODUCTION OF THE PRECIOUS METALS—ENCOURAGEMENT OF VEIN MINING—GOVERNMENT PROTECTION AND LEGISLATION REQUIRED—IMPORTANCE OF A NATIONAL MINING COLLEGE—ORGANIZATION OF A CORPS OF MINING ENGINEERS SUGGESTED.

USE OF THE PRECIOUS METALS FOR MONEY.

The inquiry now naturally arises, what use is made of this enormous amount of gold and silver? In what forms, and where, does it now exist? The chief use of these metals is for money—representing labor or property; next in the arts, in the form of plate, ornaments, and other objects. It would be exceedingly interesting to ascertain the total amount of gold and silver in both of these forms now in existence, in order to compare it with the amount produced. This, however, is practically impossible. The difficulties which surround such an inquiry are almost as great as those which surround the question of production. It is an inquiry which cannot be entered upon here to the extent which its importance deserves, but the few facts which have been brought together will serve to throw some light upon the subject.

During the general recoinage in England in 1774, the old and defective gold coins that were brought to the mint to be recoined produced £16,598,266 in new coins; £2,898,491 in value of new coin was also produced from ingots of foreign gold. It was supposed that there remained in circulation at the same time, within the kingdom, £5,000,000 in value of old guineas and half-guineas. The total of these sums is £25,447,002, which is supposed to have been the amount in circulation in England directly after the recoinage.

Lord Liverpool, in his letter to the King in 1805, from which the foregoing facts are derived,[1] estimates the amount of gold coin then in existence "in his Majesty's dominions" at over £30,000,000 in nominal value, and of silver coins about £3,960,435. It is also stated that M. Necker, in his treatise on the administration of the finances of France, estimated the quantity of specie circulating in that country at about £91,666,666, chiefly in silver.[2]

[1] *Vide* Lord Liverpool's Treatise on the Coins of the Realm, 4to, 1805, p. 176. [2] Ibid., p. 180.

Tooke, in his History of Prices,[1] has shown that even so early as 1560 ıe probable quantity of gold and silver coin in circulation in England nd Wales was £1,100,000. In 1688, Gregory King's estimate of the ld coins in England and Wales was £3,000,000 of silver and £8,500,-0 of gold. Mr. Morrison was led to believe that the amount of gold in in 1780 was not less than £26,000,000. Sir George Rose estimated at it was £40,000,000 in 1798.

The following are Tooke's estimates of the quantity of British gold circulation in the United Kingdom at the close of 1844 and at the se of 1866:

stimate at the close of 1844		£36,000,000
dd for efflux from the Bank of England, 1845–'49	£15,000,000	
" " " " 1850–'54	35,000,000	
" " " " 1855–'56	14,000,000	
	64,000,000	
Less gold cancelled	6,000,000	
		58,000,000
		£94,000,000

He was, however, inclined to think that the amount of gold coin in rculation in 1844 was considerably more than the £36,000,000 assumed. n the assumption that it was £46,000,000—and he was inclined to lopt that amount as highly probable—he arrived at the following ssumed gold circulation at the close of 1856:

ssumed gold circulation at close of 1844		£46,000,000
dd for efflux, 1845–'49		15,000,000
		61,000,000
dd for efflux, 1850–'56	£49,000,000	
Less exports to Australia	25,000,000	
		24,000,0000
pparent gold circulation at the close of 1859		£85,000,000

He observes further, that considering the general tenor of former timates of the quantity of gold coin in circulation in the United Kingm, it does not appear that a supposition of even £75,000,000 sterling the quantity at the close of 1866 would be unduly exaggerated.

Professor Jevons, in a recent communication to the Statistical Society London, estimates the gold in circulation in Great Britain at 0,000,000, the silver at £14,000,000, and the bullion in bank at 5,000,000 more, making £100,000,000 in all.

McCulloch, in 1858,[2] says that the gold and silver employed in Great

[1] History of Prices, vi, 701 and 702. [2] Encyclopedia Britannica, xviii, 465.

Britain as currency, and in the customary reserves in the banks, was supposed to amount to from £70,000,000 to £75,000,000, and in France to £130,000,000 or £140,000,000. He estimated the entire sum in use as money in Europe, North and South America, Australia, Cape of Good Hope and Algeria, at from £490,000,000 to £510,000,000, or a mean of £500,000,000—in round numbers $2,500,000,000.

In regard to the metallic circulation of France there is a wide difference in the estimates. Chevalier estimated it at 2,500,000,000 francs, about $500,000,000. Roswag,[1] who has examined the subject with great care, estimates that the stock in 1865 did not exceed 3,000,000,000 francs, or $600,000,000. Mr. George Walker adds $100,000,000 to this estimate of Roswag, and considers $700,000,000 as fairly representing the total circulation of France.

The value of the precious metals circulating in Russia in the early part of 1851 was estimated at 326,000,000 of roubles—about $269,000,000.

The amount of coin in circulation in India in 1860 was estimated at £100,000,000 by Mr. Wilson. Of the amount in China we have no means of making even an approximate estimate, but it is known to be very large and to consist in a great part of Mexican dollars and silver bullion.

The amount of gold and silver in circulation and in the treasury and banks of the United States at the present time is supposed to be about $200,000,000.

In 1861 the amount was estimated by Secretary Chase at $275,000,000.

In the report of Secretary Guthrie for 1854,[2] a tabular statement is given of the estimated amounts of gold and silver in the United States at different periods. This table is appended.

Estimates of the amount of gold and silver in the United States at different periods.

Year.	Specie in circulation.	Specie in the banks.	Total in the country.	Authorities.
	Millions.	*Millions.*	*Millions.*	
1816	$7½	$15 to 19	$22½ to 26	Crawford and Gallatin.
1819	8	29	37	Crawford.
1819	....	15½	....	Congressional report.
1820	....	19½	....	Gallatin.
1829	8½	22¾	31¼	Woodbury.
1830	10	22	32	Gallatin.
1830	8	15	23	Sanford.
1833	12	30¾	42¾	Congressional report.
1833	4	25	29	Taney.
1836	25	40	65	Woodbury.

[1] The author regrets that during the preparation of this report he has not had an opportunity of consulting the important work of M. Roswag. It is now cited from the letter of Mr. George Walker to the Hon. David Ames Wells, special commissioner of the revenue, Appendix B, of the commissioner's report for 1868.

[2] Senate document, second session, 33d Congress, volume 4, 1854–'55, page 280.

Estimate of the amount of gold and silver in the United States, &c.—Continued.

Year.	Specie in circulation.	Specie in the banks.	Total in the country.	Authorities.
	Millions.	*Millions.*	*Millions.*	
1837	35	38	73	Woodbury.
1838	52½	35	87½	Do.
1839	42	45	87	Hazard, (Commercial Register.)
1840	50	33	83	Woodbury.
1841	35 to 45	35	70 to 80	Gouge, (Journal of Banking.)
1844	50	50	100	Hunt, (Merchant's Magazine.)
1845	52	44	96	Bank returns and estimates.
1846	55	42	97	Do.
1847	85	35	120	Bank returns and estimates. (Constitutional treasury began to operate.)
1848	66	46	112	Bank returns and estimates.
1849	77	43	120	Do.
1850	109	45	154	Do.
1851	138	48	186	Do.
1852			204	Estimates.
1853			236	Do.
1854	181	60	241	Bank returns and estimates.

STATISTICS OF COINAGE.

The statistics of coinage in different countries, although they cannot be taken as accurately representing the amount of the precious metals in circulation, are important in this connection.

Chevalier says:[1] "During the government of Napoleon I, the coinage of gold amounted to 527,000,000 francs, or an average of 48,000,000 per annum. Under Louis XVIII it was a smaller proportion, amounting to a total of 389,000,000 francs, or an average of 39,000,000 per annum. Under Charles X a great decline is observable; for during the whole reign the gold coinage amounted to only 52,000,000 francs. During the 17 years of Louis Philippe's reign gold was only coined to the amount 215,000,000 francs, or 12,500,000 annually. The ascending reaction began to manifest itself in 1848, for in the general distress caused by the revolution of that year many persons carried their gold plate to the mint to be converted into money; but the influence of the new mines is not perceptible till after 1850. During the period of eight years, ending December 31, 1857, the gold coined at the Paris mint amounted to two 2,750,000,000 francs, or an average of 343,000,000 yearly. During the period of 45 years, comprised between the seventh *Germinal*, year 11, and January 1, 1848, it had only been one 1,186,000,000, or 22,300,000 francs per annum. The greatest amount coined in one year was in 1857, when it reached 572,561,225 francs.

According to a late official statement of M. Pelouze, the total coinage of the French mint since 1795, the date of the establishment of the mon-

[1] On the probable fall in the value of gold, &c., &c., by Michel Chevalier. Translation by Cobden. Appleton's edition, p. 59.

etary system, up to the 1st of January, 1866, and the amount of decimal coinage officially withdrawn from the circulation in the same period, was as follows:

		Francs.
Gold coinage		6,572,113,57[illegible]
Withdrawn from circulation		71,082,8[illegible]
Difference		6,501,030,71[illegible]
Silver coinage	4,673,156,456	
Amount withdrawn	66,280,101	
Difference		4,606,875,3[illegible]
Total of [illegible]		11,107,907,0[illegible]

GOLD.

Denominations.	100 francs.	50 francs.	40 francs.	20 francs.	10 francs.	5 francs.	Total.
	Francs.	*Francs.*	*Francs.*	*Francs.*	*Francs.*	*Francs.*	*Francs.*
Amount coined	36, 837, 300	41, 839, 300	204, 432, 360	5, 231, 002, 360	866, 758, 080	191, 244, 170	6, 572, 113, 570
Deducting the pieces withdrawn from circulation					48, 589, 920	22, 492, 940	71, 082, 860
There remains in circulation	36, 837, 300	41, 839, 300	204, 432, 360	5, 231, 002, 360	818, 168, 160	168, 751, 230	6, 501, 030, 710

SILVER.

Denominations.	5 francs.	2 francs.	1 franc.	50 centimes.	25 centimes.	20 centimes.	Total.
	Francs.	*Francs.*	*Francs.*	*Francs.*	*Francs. Cent.*	*Francs. Cent.*	*Francs. Cent.*
Amount coined	4, 435, 139, 860	72, 972, 442	90, 572, 350	60, 964, 943	7, 671, 101 25	5, 835, 769 40	4, 673, 156, 456 65
Deducting the pieces withdrawn from circulation [1]	52, 373, 700			4, 979, 085	7, 671, 101 25	1, 256, 215 00	66, 280, 101 25
There remains in circulation	4, 382, 766, 160	72, 972, 442	90, 572, 350	55, 985, 845		4, 579, 554 40	4, 606, 876, 355 40

[1] Pieces remelted for China .... francs.. 15, 000, 000
Pieces remelted to make one-franc pieces and fifty-centime pieces, before the law of the 25th of May, 1864 .... do.... 28, 199, 000
Pieces remelted by virtue of the law of the 25th of May, 1864 .... do.... 9, 174, 700

Sum total, francs 52, 373, 700

The records of the British mint show that in the 23 years from 18[illegible] 1865, inclusive, gold was coined to the amount of £120,689,928, and si[illegible] to the amount of £7,449,499, making in all £128,139,427, as shown in following table:[1]

Coinage of gold and silver at the British mint, 1843 *to* 1865.

Years.	Gold and silver coined at the mint.		Light coin withdrawn circulation.	
	Gold.	Silver.	Gold.	Silv[illegible]
1843	£6,607,849	£239,580	£2,550,893	£1[illegible]
1844	3,563,949	610,632	3,314,122	[illegible]
1845	4,244,608	647,658	718,075	[illegible]
1846	4,334,911	559,548	609,143	[illegible]
1847	5,158,439	125,730	660,477	[illegible]
1848	2,451,999	35,442	800,820	[illegible]
1849	2,177,955	119,592	611,139	[illegible]
1850	1,491,836	129,096	465,673	[illegible]
1851	4,400,411	87,868	641,636	[illegible]
1852	8,742,270	189,597	430,608	[illegible]
1853	11,952,391	701,545	403,786	[illegible]
1854	4,152,183	104,480	474,766	[illegible]
1855	9,008,663	195,510	379,563	[illegible]
1856	6,002,114	462,528	419,121	[illegible]
1857	4,859,860	373,230	511,000	[illegible]
1858	1,231,023	445,896	393,000	[illegible]
1859	2,649,509	647,064	334,000	[illegible]
1860	3,121,708	218,403	374,000	[illegible]
1861	8,190,170	209,484	581,000	[illegible]
1862	7,836,413	148,518	618,000	[illegible]
1863	6,607,456	161,172	482,000	[illegible]
1864	9,535,597	535,194	456,000	[illegible]
1865	2,367,614	501,732	645,000	[illegible]
	£120,689,928	£7,449,499	£16,882,790	£1,7[illegible]

Amount of gold and silver coined at the mint between 1843 and 1865	£128,1[illegible]
Amount of light gold and silver coin withdrawn from circulation during the same period	18,6[illegible]
	£109,4[illegible]

Showing an average addition of £4,760,400 a year to the stock of [illegible] in the country, which would not be needed if small notes were allo[illegible] to be issued.

This table also shows the amount of light gold and silver coin w[illegible] drawn from circulation during the same period, £18,650,208. [illegible] amount deducted from that of the new coins shows a differenc[illegible] £109,489,219 added to the metallic currency of that country in 23 y[illegible]

The average gold coinage of England slightly exceeds £5,000,0[illegible] year. The average cost of coining a sovereign, including all the [illegible]

[1] From "The Science of Finance," by R. H. Patterson—Edinburgh and London, [illegible] pages 43 and 679.

[ex]penses, is found to be 0.72 penny, and the estimated expense of recoin[in]g 50,000,000 of sovereigns is £279,975. The cost per sovereign, [ta]king the actual expenses during 11 weeks, when 5,663,656 pieces were [co]ined, was found to be 0.311*d.* per piece, or $\frac{13}{100}$ of 1 per cent. of the [v]alue of the gold.[1]

Statistics of coinage of the United States, Great Britain and France, [w]ere presented by Mr. S. B. Ruggles in his written argument in favor of [a] 25-franc coin submitted at the sixth sitting of the International Mone[t]ary Conference held during the progress of the Exposition, and they [a]re here given:

[I]. The gold coinage of the United States in the 57 years from 1792 to 1849, next preceding the outburst of gold in Californiain 1849, was	$85,588,038
[I]n the next two years, 1849 and 1850	94,596,230
[I]n the next 15 years, 1851 to 1866	665,352,323
Total	$845,536,591

[I]I. The gold coinage of Great Britain in the 35 years from its reform, in 1816, to 1851, was £96,021,151, or	$480,105,755
[I]n the 15 years from 1851 to 1866, £91,047,139, or	455,235,655
Total	$935,341,450

III. The gold coinage of France in 58 years, from 1793 to 1851, was, in francs, 1,622,462,580, or	$324,492,516
In the 15 years, under the empire of Napoleon III, from 1851 to 1866, in francs, 4,938,641,490, or	987,728,298
Total	$1,312,220,814

Summary.

Total coinage by the three nations before 1851:	
By the United States	$180,184,268
By Great Britain	480,105,755
By France	324,492,516
Amount	$984,782,639
From 1851 to 1866:	
[B]y the United States	$665,352,323
[B]y Great Britain	455,225,695
[B]y France	987,728,298
Amount	$2,108,356,316

[1] From the testimony of Robert A. Hill, esq., assistant coiner of the royal mint.

In regard to the coinage of the United States, and other nations, Mr. Ruggles observes:

"The amount coined by the United States having been $845,536,591, if two-thirds shall be deducted for the portion recoined in Europe or used in the arts, the amount remaining which would require recoinage (for the purpose of unification) would not exceed, in round numbers, $300,000,000. It is true that a portion of the coin of the United States exported to Europe is sent without recoinage to Germany and other continental nations, for the use of their people emigrating to the United States. But if we allow $200 *per capita* (which, including women and children, would be a large estimate) for 150,000 emigrants, it would amount only to $30,000,000. In view, moreover, of our large importations of foreign merchandise, with our temporary disuse of gold for domestic purposes, even the estimate of $300,000,000 may be too large. The recoinage, however, of the whole amount would cost, at one-fifth of one per cent., (the rate ascertained by experience,) only $600,000."

Mr. Ruggles states that the amount of gold now in actual circulation in France, Belgium and Italy is estimated by M. de Parieu and other distinguished economists of Europe at 7,000,000,000 of francs, or $1,400,000,000, and that the amount in circulation in the residue of continental Europe would probably carry the total to $1,800,000,000. He further observes:

"The estimate of $1,400,000,000 as the gold circulation of France, Italy, and Belgium, will not be regarded as exaggerated when we consider the heavy drain of silver from France during the last 15 years, in connection with the fact that its silver coinage from 1795 to 1851 had amounted to 4,457,595,345 francs, or $891,519,069. Of this large amount, at least $750,000,000 are said to have been exported within the last 15 years, principally to the East Indies, leaving the amount of silver now in circulation in France not exceeding $150,000,000.

"The coinage of silver at the royal mint of Great Britain in the 10 years from 1857 to 1866, both inclusive, was only £3,677,182, or $18,385,910. The total coinage of silver in France during the reign of the present Emperor, in the 15 years from 1851 to 1866, was only 215,561,101 francs or $43,112,180. The silver coinage of France, Great Britain, and the United States, from 1851 to 1866, was in round numbers only $117,000,000, against a gold coinage, in the same period, of $2,108,000,000.

"So severe, indeed, had become the destitution of small silver coin in 1865, that the treaty of the 23d of December, of that year, authorizing the issue of silver of denominations less than five francs, reduced its standard about 7 per cent., (from .900 fine to .835 fine,) to prevent its further disappearance. At the same time, it limited the amount to be coined in France to 239,000,000 francs, or $47,800,000.

"Fortunately for France and the commercial world, the surplus gold of the United States was at hand during these 15 years, ready to be recoined. Steadily filling the immense vacuum caused by this great export of silver, it now invigorates every branch of industry in France.

Ɩhe monetary movement in these 15 years on the waters of the globe ally illustrates the power of the oceans not to divide but to unite the :inents in a common 'solidarity.' Subdued by steam to the use of ı, they are now incessantly ministering to the wide-spread monetary ›ssities of the human race. It needs but a glimpse of their statistics nap out the great oceanic monetary currents. Within that brief od, only the dawn of the opening auriferous era, we discern a mass ;old, in the aggregate exceeding $500,000,000, moving across the intic from the United States; another and still larger volume of 3,000,000 pouring out from Australia upon the surrounding oriental ers, and at least one-half finding its way to London over the Indian ın, the Mediterranean, and the Atlantic; another golden mass of 0,000,000 crossing the British channel into France, while the great nter-current of $565,000,000 of silver, largely derived from France, is ı flowing out of England and up the Mediterranean on its way to the r-absorbing East."

'rom the annexed summary exhibit of the coinage of the United tes mint and its branches up to the close of the fiscal year ending ıe 30, 1868, it will be seen that the total coinage from the commence- nt is:

ld	$909, 516, 715 67
ver	130, 507, 493 62
Total of gold and silver	$1, 040, 024, 209 29

nmary exhibit of the coinage of the mint and branches to the close of the fiscal year ending June 30, 1868.

Mints.	Commencement of coinage.	Gold coinage.	Silver coinage.	Copper coinage.	Entire coinage.	
		Value.	*Value.*	*Value.*	*Pieces.*	*Value.*
ıdelphia	1793	$441, 904, 870 50	$90, 702, 984 74	$9, 128, 548 55	1, 033, 853, 686	$541, 736, 403 79
Francisco	1854	250, 474, 656 81	6, 683, 957 17	....	26, 129, 483	257, 158, 613 98
Orleans, (Jan '61.)	1838	40, 381, 615 00	29, 890, 037 13	....	94, 890, 695	70, 271, 652 13
lotte, (Mar. 31, .)	1838	5, 048, 641 50	....	....	1, 206, 954	5, 048, 641 50
onega, (Feb. 28,)	1838	6, 121, 919 00	....	....	1, 381, 780	6, 121, 919 00
Office, New rk.	1854	163, 901, 963 17	3, 230, 514 58	....	....	167, 132, 477 75
er	1863	1, 683, 049 69	....	....	....	1, 683, 049 69
otal	......	909, 516, 715 67	130, 507, 493 62	9, 128, 548 55	1, 157, 462, 598	1, 049, 152, 757 84

Table V, in the appendix, shows in detail the amounts coined in each year, and the following gives the averages of coinage for each decade, 1793 to 1868, inclusive:

Recapitulation of averages of coinage for each decade from 1793 to 1868, inclusive.

Years.	Gold.	Silver.	Copper.	Total.
1793–1800, 8 years	$126,786 25	$180,056 84	$9,923 85	$316,7[illegible]
1801–1810, 10 years	325,074 25	356,916 52	15,124 64	697,115 [illegible]
1811–1820, 10 years	316,651 00	597,081 09	19,115 86	932,847 [illegible]
1821–1830, 10 years	190,309 25	1 678,104 69	15,141 22	1,882,5[illegible]
1831–1840, 10 years	1,879,186 20	2,719,977 90	34,232 22	4,633,3[illegible]
1841–1850, 10 years	8,944,332 80	2,222,675 50	38,067 08	11,205,07[illegible]
1851–1860, 9½ years	49,561,913 79	5,061,869 80	131,538 16	54,755,[illegible]
1861–1868, 8 years	40,138,587 46	1,778,964 82	822,840 62	42,740,[illegible]

USE IN THE ARTS, AND LOSS BY WEARING.

The estimates made by Jacob of the amount of the precious metals used in the arts have already been partly presented. He thought that it amounted in 1830 to about £5,900,00 a year. This is thought by many to be an under estimate. McCulloch thought that the value of gold and silver in Great Britian, in 1857, in the shape of plate, watches, jewels, and trinkets, might be safely estimated at £4 to each individual of the entire population, or a value in the aggregate of about £88,000,000, and adding £12,000,000 for Ireland, to £100,000,000. Extending the estimate to other countries, he concludes that in Europe, America, and Australia, the amount so used cannot be less than from £15,000,000 to £16,000,000 yearly. "But of this a portion, estimated at one-fifth or 20 per cent., is supposed to be obtained from the fusion of old plate, the burning of lace, picture frames, &c. And hence, if we duduct from the £15,000,000 used in the arts 20 per cent. for the old bullion, we have £12,000,000 for the total quantity of the supplies from the mines annually disposed of in this way, a considerable portion of which, including that used in the gilding of rooms, earthenware, books, harness, buttons, &c., cannot be again recovered or applied to any useful purpose."[1]

A very large amount of silver and gold is now annually consumed in electro-gilding and silvering of household plate, and trimmings of various kinds, but it should be noted that articles plated in this way have replaced to a considerable extent those of solid silver and gold, or at least that the manufacture of solid silver ware has not increased as it would if this art had not been discovered.

It is stated that one establishment in the United States—the Gorham Manufacturing Company—uses up 26 tons of silver annually, or 2,000 ounces a day, in the production of silver-ware and plate.

The amount of loss of the precious metals during transmission by sea and land and in circulation is difficult to ascertain with any precision,

[1] Ency. Brit. xviii, 466.

but it is an element which must enter into any calculation of the amount of these metals in existence. Considerable attention appears to have been given to this subject, but the investigations generally seem to have been very loosely conducted, and the results are altogether unsatisfactory as a guide for an estimate of the annual loss at the present time. The estimate by Jacob has already been explained, page 201. He assumed that the money in circulation, or rather the total stock of bullion, was diminished 10 per cent. in each period of 36 years, and upon this assumption he makes a total deduction of $188,000,000 for the period from 1492 to 1809.

In the years 1787 and 1798 experiments were made by the officers of the royal mint to ascertain the deficiency of weight of the various silver coins in use. In 1787 it was found that $12\frac{8}{10}$ crowns, or 27 half crowns, or $78\frac{1}{10}$ shillings, or $194\frac{6}{10}$ sixpences, were requisite to make up a pound troy, instead of $12\frac{4}{10}$ crowns, or $24\frac{8}{10}$ half crowns, or 62 shillings, or 124 sixpences, as issued from the mint.

In 1789 it was found that $12\frac{33}{40}$ crowns, or $27\frac{21}{40}$ half crowns, or $82\frac{9}{40}$ shillings, or $200\frac{37}{40}$ sixpences, were requisite to make up a pound troy, instead of $12\frac{16}{40}$ crowns, or $24\frac{32}{40}$ half crowns, or 62 shillings, or 124 sixpences, as issued from the mint.

Comparing the deficiency of weight of these several denominations of silver coins with their legal weight as issued from the mint, the loss amounts in the crowns to $3\frac{161}{513}$ per cent., in the half crowns to $9\frac{991}{1101}$ per cent., in the shillings to $24\frac{1964}{3289}$ per cent., in the sixpences to $38\frac{2294}{8037}$ per cent.

"It is singular that these several silver coins, particularly the shillings and sixpences, though in general they retain no remains of any impression, or any rough edges, which would make them subject to friction, appear to have diminished by use, in the short interval of eleven years, according to the experiments above mentioned, in the following proportions:[1] crowns, $\frac{100}{513}$ per cent.; half crowns, $1\frac{333}{367}$ per cent.; shillings, $5\frac{55}{3289}$ per cent.; sixpences, $3\frac{1189}{8037}$ per cent."

Woolhouse says that the wear and tear of the gold coinage is such that very nearly 3 per cent. of the whole circulation goes out annually, and the quantity which suffices to throw a sovereign out of circulation is $\frac{257}{1000}$ parts. McCulloch, taking into account the extraordinary extension of navigation and emigration, the risks of shipwreck and other accidents, estimated the loss, including wearing, at about $1\frac{1}{2}$ per cent. of the entire mass of the currency.

The testimony given before the royal commission on international coinage by J. Miller, of the weighing room of the bank of England, contains some valuable data upon the loss of weight of sovereigns by wear.[2] One thousand sovereigns, as issued from the mint, weighed, in parcels of 100 each, 25.68 ounces, or 256.80 in bulk, value at £3 17*s.* 10½*d.* per ounce, £999 18*s.* 2½*d.*, or 20*s.* each; 3,000 sovereigns, as in circulation, weighed,

[1] Lord Liverpool's Treatise, pp. 187, 188. [2] Report, 1868, p. 94.

in parcels of 1,000 each, 255.87 ounces, 255.76 ounces, and 255.80 ounces, or an average of 19*s.* 11*d.* each.

The wear of coins is chiefly upon the small coins in active circulation for retail trade. The balances of larger transactions are liquidated by notes and checks without the movement of specie. In England not more than 5 per cent. of banking transactions, amounting in 1866 to £4,588,000,000 sterling, are in notes and coin, and but little more than one-half of 1 per cent. in coin.[1]

The clearing-house system, in addition to its other great advantages, is a great economizer of wear and tear of the precious metals. The enormous transactions in gold, at the present time, in New York do not involve the movement of the metal. The balances are liquidated by checks and gold certificates.

The following remarks upon the importance of maintaining coin in good condition are extracted from the report of the Director of the United States mint for 1867:

MAINTENANCE OF COIN IN GOOD CONDITION.

"There is a subject which, I believe, has not been brought to the attention of the law-making power, and the present seems to be a proper opportunity. If it is the duty of government to keep the paper currency in good repair, as is acknowledged and practiced, it cannot be otherwise in regard to the metallic currency, whether of gold, silver, or copper. A wealthy and refined people, accustomed to keep everything about them in good order, ought to have the same attention paid to the current money, so constantly in their hands and their pockets. As far as practicable, it ought to be kept neat and legible; it ought not to be worn to smoothness, nor, in the case of precious metals, be materially reduced in bullion value.

"This doctrine has been recognized in England, where, in 1774 to 1788, there was a great recoinage of the old worn-out guineas, at an expense to the treasury of over half a million pounds sterling. Another instance has just been brought to our notice. In 1866 a large amount of worn silver coin was received from the Bank of England, and recoined.

[1] To show approximately the proportion of banking transactions which are settled through the clearing-house, Sir John Lubbock, (in a paper read before the Statistical Society in June 1865,) made the following analysis of twenty-three millions sterling which passed through his bank in a few days:

Amount settled through clearing-house	£16,346,000 or 70 per cent.
Checks and bills not passed through clearing-house	5,394,000 or 24 per cent.
Bank notes	1,216,000 or 6 per cent.
Coin	139,000 or 6 per cent.
	£23,095,000

From this statement it appears that 70 per cent. of banking transactions are settled through the clearing-house, and consequently without the use of money. Of the remainder, a 24 per cent. are settled without the use of money by means of checks and bills; nearly 6 per cent. are settled in bank notes, and little more than one-half per cent. in coin.

"In general, when a renovation of coins has been effected, it has been ı the occasion of reducing the standards, either of weight or fineness, · both. Such has been the case in this country, and in England, rance, Germany, Spain, and other countries. This is a very cheap ay of keeping the coins in order; but even where there is no such duction, a recoinage of worn and spoiled pieces would not be a very rious charge upon the treasury, because (unlike the paper moneys) ıey constitute but a small part of the pieces circulating. They wear ery slowly, for one thing. But the more important consideration is ıat they are constantly going abroad, where they find their way to the reign melting pot and reappear with other names and devices. Of all he many millions that have been coined here, in gold and silver, a very mall proportion now bears the stamp of the United States; and when he sovereigns, francs, and thalers come back to us, we treat them in he same way; so that a busy commerce keeps the coinage new and ;ood, and lightens the loss which might otherwise be vexatious and urdensome. Still, in specie times, there is much gold and silver curent that ought not to be; and that which is worst circulates most, by a ixed law of human sagacity or self-care.

"If this proposition be true of gold and silver, it is no less so of copper r nickel coins. They ought to be kept clean and legible, and when they ease to be so, the mint ought to be authorized and enabled to take them ack, and give new pieces in their stead."

CURRENT OF THE PRECIOUS METALS.

The current or movement of the precious metals appears to have always een counter to the march of civilization, or from the new to the older untries. As discovery and settlement has progressed from east to west, om Asia to Europe, from Europe to the Americas and to Australia, so e gold and silver has been constantly flowing backward upon the same ıes, from Europe to Asia, and from America and Australia to Europe. It may be asserted that in general the flow of the precious metals is ways from those countries where the value of the imports exceeds the lue of the exports, and towards those where the value of the exports ceeds the value of the imports. The balance of trade is settled with ld and silver. This balance of trade has long been in favor of India ıd China, and there has been a constant flow of the precious metals in at direction. The total amount of bullion absorbed in India from 1800 1864 exceeded £256,000,000, and the bullion coined in India from 1800 1865 exceeded £231,000,000.[1]

In 1863 the gold and silver sent to India exceeded the exports by 19,398,315. The amount sent in fourteen years, from 1851 to 1864, clusive, appears to have been nearly $651,000,000,[2] or an average of out $46,500,000 a year, as shown by the annexed table.

[1] Statesman's Year Book, 1868.

[2] Hunt's Merchants' Magazine and Mineral Resources U. S., p. 621.

Exports of gold and silver to Asia in fourteen years.

	England.	Mediterranean.	Total.
1851	$8, 362, 500		$8, 362, 500
1852	12, 116, 210		12, 116, 210
1853	23, 550, 000	$4, 240, 000	27, 790, 000
1854	15, 555, 000	7, 255, 000	22, 821, 000
1855	32, 075, 000	7, 620, 000	39, 695, 000
1856	60, 590, 000	9, 950, 000	70, 540, 000
1857	86, 477, 170	10, 180, 291	96, 657, 461
1858	25, 444, 250	16, 150, 000	31, 594, 250
1859	33, 298, 120	7, 340, 280	40, 638, 400
1860	40, 620, 182	8, 120, 204	48, 740, 386
1861	36, 399, 175	7, 980, 000	44, 379, 175
1862	53, 551, 045	9, 150, 000	61, 701, 145
1863	38, 236, 191	29, 281, 000	67, 517, 191
1864	37, 079, 196	41, 255, 942	78, 335, 139
Total in fourteen years	$503, 365, 035	$147, 522, 718	$650, 885, 753

Professor Jevons, in an article upon the variation of prices and the value of currency since 1782, says:[1] "Asia, then, is the great reservoir and sink of the precious metals. It has saved us from a commercial revolution, and taken off our hands many millions of bullion which would be worse than useless here. And from the earliest historical ages it has stood in a similar relation to Europe. In the middle ages it relieved Europe of the excess of Spanish American treasure, just as it now relieves us of the excess of Australian treasure. The 'Indian trade,' says Macpherson,[2] 'arose to a considerable magnitude at the same time that the American mines began to pour their treasures into Europe, which happily has been preserved, by the exportation of silver to India, from being overwhelmed by the inundation of the precious metals, as it must have been had not such exportation taken place.' And 'Ragnal affirms that the Spaniards must have abandoned their most productive mines of silver in America, as they had already abandoned many of the less productive ones, if the progress of the depreciation of silver had not been somewhat retarded by the exportation of it to India.'"

Lees, who has written upon the drain of silver to the East, estimating the currency of India as equal to that of Great Britain, or £80,000,000, and the population at 180,000,000, says:

"It requires but very little calculation to show that India is capable of yet absorbing silver to the amount of Rs. 4,000,000,000, or £400,000,000, in addition to this amount for the purposes of currency alone. Nor must it be forgotten that India is able to support a population many millions more numerous than she at present possesses; nor on the other hand that England has many means of economizing the use of coin, which, in consequence of her immense extent of area, will be denied to India."

[1] Journal Statistical Society, London.

[2] Commerce with India, p. 57.

not forever, for many years to come. If, then, it be admitted that there is even a shadow of truth in these estimates, it may not be unreasonable to conclude that there is a possibility, distant it may be, yet still a possibility, of the requirements of India for currency purposes approaching the enormous sum of £500,000,000 in silver coin.[1]

DECREASE IN THE PRODUCTION OF GOLD.

The statistics of the production of gold in California, Australia and other countries show very clearly the familiar fact that in all newly discovered gold regions a maximum production is soon attained and is succeeded by a gradual but certain decrease owing to the exhaustion of the placer deposits. Thus, in California, the maximum product was attained in the year 1853, when the shipments were about $55,000,000, and the production was doubtless from $60,000,000 to $65,000,000 in value. It is now much less than half of that amount. In Australia, in the same year, (1853,) the reported shipments from Victoria amounted to 3,150,020 troy ounces, and the production was nearly $60,000,000 in value.[2] In 1867, the shipments were only 1,433,687 ounces, much less than half as much as in 1853. The apparently nearly uniform production of California for the past ten years, judging from the shipments of treasure from the port of San Francisco, is the result of the opening of other gold and silver producing regions in Nevada, Idaho, Oregon, and Arizona, which, so far as their production depends upon placers, are in their turn liable to rapid exhaustion. In British America and in Idaho and Montana the production of gold is now rapidly diminishing.

Russia is the only country in which a nearly uniform production has been maintained through a series of years. This may perhaps be explained by the fact that the mines have not been free to all, and consequently comparatively few persons have been engaged in developing them. The climate, also, is unfavorable to rapid and continuous working, and the method of washing placer gravel by machinery in use there is necessarily slow and gives limited results, which cannot compare with those obtained by the gigantic system of sluicing practiced in California, and Australia. There has also been in Russia a constant extension eastward of the gold region by new discoveries, extending even to the Pacific coast, and there is doubtless an immense area of virgin ground from which the gold supply of Russia may be for a long time maintained at the present figures, or, possibly, greatly increased, especially if all restrictions upon mining are removed, and the country is thrown open to the skilled miners of other regions. This Siberian gold field, with the great mountain region south of it, extending into China and India, is the only extended region now known in regard to which there is any uncertainty in respect to its probable future yield of gold.

[1] The Drain of Silver to the East and the Currency of India, by W. Nassau Lees: London, 1864.

[2] Calculated at $19 per ounce.

The existence of very ancient workings in the Altai is significant, and leads us to question whether this great interior region has not already yielded up its most accessible treasures.

PRODUCTION OF GOLD FROM PLACERS AND FROM VEINS COMPARED.

It must be remembered that the production of gold from placers is necessarily transitory and comparatively abnormal, inasmuch as the placer miner takes advantage of the work which has been performed by the grand operations of nature extending over enormous periods of time. He, in fact, "cleans up" gold which has been already mined. The force required to detach the metal from its rocky matrix has been applied. The vein-stone has been broken out and ground up by the power of streams rolling for unnumbered ages over the rocks, and by the resistless power of glaciers, covering the mountains, filling the valleys, and everywhere cutting away the rocks and veins of the mountains, and throwing the fragments into the rivers, there to be ground and distributed by the currents in terraces and bars while the grains of gold settle to the bottom.

To obtain an ounce of gold from a ton of quartz rock requires a certain amount of force. The rock must be broken and ground to dust. The operation is slow and tedious. It may be said, in truth, that every ounce of gold in placers has required the expenditure of force equal to that now required to extract the same quantity from veins. The advantage in cheapness of production which the placer miner has over the quartz miner is thus made manifest. The work of mining and crushing has been performed for him by nature.

As soon, therefore, as placer deposits are comparatively exhausted the miners will be driven to the veins, a normal production of gold will begin, and it may be said, in general, that every ounce of gold, wherever produced, will require a nearly equal expenditure of power. Of all metals gold is the most uniform in its mode of occurrence. The conditions in which it occurs in veins are nearly the same in all parts of the world. Its common matrix is quartz, and the percentage of the metal in the vein-stone in all workable veins may be considered as remarkably uniform. Other metals are found in a variety of conditions; sometimes with one matrix and sometimes with another of a very different nature and hardness. They are also in combination with a variety of elements from which it is more or less difficult to separate them, and the quantity of such metals in different veins varies greatly. They may thus be produced in some places or countries very much cheaper than in others. The cost of transportation varies greatly. The conditions of production are so varied and different in different parts of the world that these metals require in some places much more or less labor than at others, and thus a given weight of the products can never represent a constant or uniform expenditure of labor. Not only mechanical but chemical processes are involved for their isolation. With the metal gold in

veins, on the contrary, the conditions are so simple and similar that to produce a given weight of it requires nearly the same amount of labor in any part of the world.[1] It does not occur like the ordinary metals in great beds and masses, but is disseminated in comparatively small grains in a vast amount of hard rock. The operation of separating it from this rock is simply a mechanical one. The quartz must be crushed and ground, and as the hardness of this mineral is nearly the same all over the world, and as the percentage of gold in all workable veins of it is remarkably even,[2] compared with workable veins of silver or other metals, it will be seen that gold is the best measure or evidence of applied power or labor that we can have. It is this, combined with the other valuable qualities of the metal, its utility, beauty, and indestructibility, and its almost universal distribution[3] that renders it above all other substances the most appropriate and desirable for money.

PROBABLE RISE IN THE VALUE OF GOLD.

In proportion as the miners exhaust the store of mined gold, which nature has so bounteously deposited in the placers, the gold production will become more equable and constant, and, at the same time, more costly. We may confidently rely upon a large production from veins in the future, especially if such mining is encouraged by suitable legislation. Yet under the most favorable conditions the production of gold from veins cannot be expected to be as great and rapid as it has been from the placers. With this continued decrease in the annual production it seems probable that gold will soon begin to sensibly appreciate in value unless some new and unlooked for discovery of placers shall be made, of which, however, there does not appear to be much probability.[4]

It was argued by Chevalier and others soon after the great discoveries of gold in California and Australia, that gold would necessarily depreciate in value—that its purchasing power was destined to be much lessened

---

[1] This, of course, is stated in a very general way, and there may be exceptions.

[2] It is not here intended to maintain that there are not great differences in the richness of veins within certain limits, but that the range of difference in general is not great. The general average yield of the most profitable mines is generally not over \$15 to \$20 per ton. Of 66 veins in Tuolumne county, California, visited by Mr. Remond, the average yield was about \$28 per ton, the extremes being \$4 and \$180. The two highest yields, viz., \$107 and \$180, were from veins respectively six inches and two inches in thickness. Excluding these two the average of the remaining 64 veins or mines is \$25 per ton.

[3] The distribution of gold may be said to be coincident with the mountain chains of the globe. There is no extended region, no great political division of the globe without its gold fields. It is a notable fact, also, that it occurs chiefly in mountain regions where water-power can be readily obtained for its extraction.

[4] The great and at present but imperfectly known gold region of Siberia and China, has already been mentioned, pp. 96 and 102. There is in addition to this a possibility of extensive virgin placers being found in Africa ; some indications of the existence of a valuable gold region there have already been discovered. Some recent discoveries are reported in Mexico, but these are probably quite local in extent.

by the great influx of the metal from these new sources. But the relative value of gold has not changed as much as was expected, and it would now seem that the supply did not more than keep pace with the ever-increasing demands of commerce and industry, stimulated as they have been by an increased supply of gold. The wonderful increase of the industrial activity of the world, resulting chiefly from the varied developments and applications of the physical sciences, has been sufficient to appropriate all the excessive production of the past 20 years.[1]

In regard to the effect of the increased production of gold upon prices, Professor Jevons makes the following general observations:

"If the state of prices here [Great Britain] then depends upon prices in India, we should be backward in making predictions of their future course. But we may speak with the more confidence of the accomplished results of the gold discoveries. Prices had been falling with little interruption from 1810 to 1849. The years 1836–'39 form a temporary but remarkable exception. In 1849–'52 prices were unprecedently low, and *cæteris paribus*, we might have expected that after another period of speculation, and its corresponding relapse of trade, prices should descend still lower. But prices in 1858 were still 18 per cent. above those of 1852.

"Since 1858 enormous fluctuations have taken place in the price of many commodities. The price of cotton has been quadrupled and again halved. Corn has fallen to what seems a natural minimum price, and meat and fodder have greatly advanced. There has been a great recent fall, too, in the price of many kinds of imported produce, yet when the average of all kinds of commodities is struck we find that prices since 1858 have been uniform in an unprecedented manner. The average fall since last year has been trifling. If we compare prices now (1865) with what they were at their lowest in 1849, we find there has been a rise of 21 per cent. If we take the average of 1845–50 as our standard of comparison the rise is 11 per cent. The real permanent rise due to the gold discoveries is probably something between these, or nearer the higher limit, 21 per cent. The gold discoveries have caused this rise of price. They have also neutralized the fall of prices which might have been expected from the continuous progress of invention and production, but of which the amount is necessarily unknown. It may be confidently asserted, then, that the Californian and Australian discoveries have had a considerable effect in reversing the previous course of prices, but it is impossible to state the amount of that effect with any approach to certainty."[2]

The demand for money increases with the increased activity of trade

[1] "The power of man is already increased immeasurably beyond the force which is inherent in himself, and the result is the same as if human force had experienced an extraordinary development. One man is now equal in productive power to ten or twenty men in earlier times. To multiply the potency of a thing is practically the same as to multiply the thing itself—indeed, in many cases, it is very much better. If we are to take into account the vast number of steam engines in use other than locomotives, it is not beyond the truth to say that the power of man in Europe has been trebled during a single generation by the appliance of steam power alone."—*Patterson*, "*The Science of Finance*," pp. 93, 94.

[2] Journal Statistical Society of London, xxviii, pp. 307, 308.

and industry. Industrial expansion is so directly affected by the scarcity or abundance of money that an increase in the rate of discount by the Bank of England represses industrial enterprises and paralyzes trade. The circulation of money is checked and it accumulates in the banks. Under the old "mercantile" or protective system in England, the quantity of specie in a country was regarded as a measure of its wealth, and the object of the system was to promote importation of the precious metals.[1]

Henceforth, in view of the constantly increasing industrial development of the Christian nations, in which China and Japan are soon to participate, and in view of the decreasing production of gold—in other words, with an increasing demand and a decreasing supply—it appears inevitable that gold must soon rapidly appreciate in value. This is a possibility which should engage the attention of financiers and economists.

The revolutions in commerce which may grow out of our increased intercourse with China and Japan may result in their taking the surplus of the grain crops of the Pacific coast instead of gold and silver only in exchange for their commodities. As soon as this takes place the drain of bullion to the east will be partly arrested and lead to the accumulation of silver and gold among other nations, and thus compensate for the diminution of the product. To within a recent period, silver in preference to gold has been required for payments in China, but gold is now much more freely received than it formerly was. The shipments of gold from San Francisco direct to China have increased from $965,887 in 1854 to over $9,000,000 in 1867.

The decrease in the production of gold has been noted by Newmarch, who says it appears to have been diminishing since 1863, and that it is certain that the demand for it will increase yearly with the development of the commerce of the world, the progress of the arts and inventions, the increase of production of salaries, revenues, and the abolition of the restrictions which check industry and international exchanges. He says, also, that it must not be forgotten that sooner or later great quantities of gold and of silver will be used to replace the non-convertible paper currency yet in use in certain countries. In Europe—Russia, Austria, Italy, and Turkey—it is probable that there are at least 400,000,000 sterling of paper money, of which a great part will be gradually replaced by specie when the countries become more rich and stable in their government.[2]

---

[1] A late writer on the science of finance points out the fact that although in Great Britain the protective system has been abandoned for free trade, yet protection has been practically revived in the monetary legislation, and still more by the Bank of England. The repeated raising of the rate of discount has been applauded because it tends to increase the import and repress the export of precious metals. It is easy to see that any legislation which represses the exportation of gold and silver operates practically as a protective tariff.

[2] Newmarch, in "Enquête sur les Principes et les faits Généraux qui regissent la Circulaion Monétaire et Fiduciare," folio v, 1867, p. 539.

MEANS OF PROMOTING THE PRODUCTION OF THE PRECIOUS METALS.

ENCOURAGEMENT OF VEIN MINING.

In view of the continued decrease in the production of gold from placer deposits, it becomes important to encourage and promote the extraction of gold from veins in every possible way. There are other great reasons for encouraging vein mining enterprises. They are permanent in their nature, and promote the general development and prosperity of the country by attracting a fixed population, composed of artisans, agriculturists, and others.[1] In California, thriving towns and villages spring up around the quartz mines in the interior, where, without the mines, all would be comparative desolation. The superficial placers in California and elsewhere are soon worked out and deserted, and the placer miners are constantly roving about without fixed homes or property. It is somewhat different in regard to the deep placers and cement mines; they partake of the nature of permanent vein mines, yet are not so attractive as centres of population.

It is an extremely encouraging fact that vein mining in California and Australia is now, or at least was in 1866, more successful than at any former period. The number of successful vein-mining enterprises is increasing. In Australia, this branch of mining appears to have been extraordinarily developed, and to be followed to relatively greater extent than in California. Of the total gold production, of nearly 1,500,000 ounces in 1866, more than 500,000 were from quartz veins. The exact ratio of the production from the two sources was as 35 to 65.

In 1867, of the total of 1,433,687 ounces exported, 560,527 ounces were taken from quartz veins, and 873,160 ounces from alluvial workings. This shows the ratio per cent. of gold produced from quartz veins to that from placers to be as 39 to 61.

It is not possible to ascertain exactly the present production of the quartz mines of California, but it is probably less than one-third of the gross yield of the State, but is increasing. The number of stamps in 1866 was 4,997, many of which, however, were idle.[2] In Australia there were 5,437 stamps. In December, 1867, the number of stamps in the several mining districts was 5,529, and the aggregate horse-power employed in crushing and hoisting was 9,555.[3]

---

[1] All gold-producing regions become large consumers, not only of the necessaries of life, but of manufactured articles of all kinds and of luxuries. This is shown in a striking manner in the gold regions of California and Australia, and in Nevada.

[2] There was no machinery of special interest to quartz miners shown in the Exposition, excepting, perhaps, the beautiful hoisting engines, steel cages, and machines for drilling rocks, and the concentrating tables of Rittinger. It is believed that the stamps and other appliances in California for the extraction of gold from quartz are unrivalled, yet there is great room for their improvement, and for improvement of processes of treating the sulphurets.

[3] Further interesting statistics of quartz mining in Australia, received since the foregoing pages of this report were printed, will be found in the appendix.

GOVERNMENT PROTECTION REQUIRED.

It is a primary duty of the government having a public domain of such great extent and wonderful richness to foster and protect mining enterprises, not only in order to promote the production of gold, silver, and ordinary metals, but as one of the best means of stimulating immigration, settlement, and the march of industry in all directions. Mining, considered in its importance to the wealth of the country, is an interest which cannot be neglected in legislation without serious loss.

The veins of gold, silver, and other metals should be regarded as the heritage of the people, and while these veins should be left free to all who choose to work them, they should not be completely abandoned to hap-hazard destructive development. The government should exert over them an intelligent protecting and directing care, and adopt such laws and regulations as will best promote permanent successful mining, preventing waste, the loss of the precious metals by careless and ignorant working, the complication and conflict of titles, and the holding of claims for merely speculative purposes, without any efforts being made to open and work them.

Nearly all the great exhibitions of mineral products in the Exposition illustrated the value of government direction and regulation of mining industry. The most satisfactory and perfect exhibitions were those made under the direction of government mining engineers. The collections were methodical and complete exhibits of the mineral resources of each country, and they were accompanied by maps and sections of mines in detail and by statistical publications prepared with the greatest care every year. The relations of position of the veins of ores and of beds of coal to the geological formations were shown by geological maps and sections and by models on a large scale, showing not only the inequalities of the surface of great districts of country, but the position of the coal beds below the surface, and the location of every mine.

By fostering mining enterprises and by thoroughly educating and training men to conduct them, many countries, whose resources in the precious and other metals are comparatively meagre, are successful producers of gold and silver from ores and veins such as in the United States would not be regarded as worth the labor of working. Every portion of an ore is utilized, and valuable products are obtained where without science and skill they would be wasted in residues. It has been shown in these pages that gold ores produced upon the slopes of the Rocky mountains and found to be "rebellious"—difficult to work—have been transported with profit, in a partly worked state, over the immense plains and across the whole breadth of the States east of the Mississippi, and then shipped across the Atlantic, to be successfully worked at Swansea, in Wales, simply for the want of a proper development of metallurgical science and industry in the United States. We must not lose sight of the fact that we not only send some of our ores abroad to be worked,

but that many of our young men are also sent abroad to obtain that thorough education and training in government institutions which they are unable to obtain at home.

IMPORTANCE OF A NATIONAL MINING COLLEGE.

The establishment of a national mining college would be one of the best or most effective means of securing the proper working of the mines and of promoting permanent and profitable mining enterprises, and thus tend to maintain a large production of the precious metals, especially from veins and deep placers, or wherever capital and skill is required. The dissemination of accurate information regarding mineral veins and their contents, and upon the various methods for extracting and reducing the ores economically, would prevent much of the present ill-directed energy and expenditure of time and money, often upon localities where there is little room to hope for success. Such institutions are absolutely necessary to gather the teachings of experience and to place them in a form available to the many persons now interested and yet to be engaged in mining, and to the prospectors who are penetrating our unequalled mineral regions in all directions and are constantly discovering new sources of wealth. The country cannot do too much to sustain and encourage the men who are thus prospecting the unexplored and almost inaccessible portions of the public domain, and to whom we are chiefly indebted for the discoveries which have been made. We should not leave them to labor unaided, but should follow them by organized explorations, by careful examinations of the veins and mineral deposits which they discover, and by the speedy publication of reliable and full information upon them. One of the prominent features of a school of mines should be practical laboratories and metallurgical works upon a moderate scale, in which the students could take practical lessons in the working of ores by all the known and approved methods, including the mechanical preparation of ores, their concentration by water and by fire in furnaces, or their reduction in pans or otherwise. These laboratories would be miniature metallurgical establishments, where ores of all kinds, "docile" or "rebellious," would be received, experimented upon, and treated by the best methods, while the theory of the processes would be fully given and the chemical reactions explained, so that the students would obtain a thorough knowledge and comprehension of the principles involved in the chemical treatment of ores and be prepared to adapt themselves to other circumstances in which they might be placed when called upon to treat ores in regions remote from supplies. Such a government mining school would not only directly promote mining industry, but it would greatly increase the amount of exact scientific knowledge among the people, and thus promote, in the most effectual manner, general scientific education, the results of which would be felt in all our industrial pursuits.

It is gratifying to all the friends of mining industry to know that the establishment of such an institution is already engaging the attention of Congress. Foremost among its advocates is Senator Stewart, of Nevada, who in 1867 introduced and ably supported a bill for the organization of a National School of Mines.

CORPS OF MINING ENGINEERS SUGGESTED.

In connection with, and as partly growing out of, such a mining college, the government should organize and make provision for a corps of mining engineers, to be filled subsequently by the graduates of the college; the members of the corps to have rank and promotion corresponding with the grades of the corps of military engineers.

Such a body of thoroughly educated men should be charged with the duty of exploration of our mineral regions; with the collection of information upon them; with the preparation of reports upon mineral deposits, and memoirs upon mining and metallurgy, all of which would form the basis for publications at regular intervals, giving to the people such information as would best promote their interests and the national prosperity.

Engineers, so educated and sustained by the government, would be animated by laudable ambition and enthusiasm, and would be strengthened by an *esprit de corps* tending to their moral and æsthetic elevation. They would be in a position to give independent and reliable opinions and advice upon the value of our mineral deposits and the best method of developing them.

Such an organization would open a new and inviting field to our young and enterprising men, the graduates of schools of science, and others, who seek a career in the fields of science.

In view of the recognized necessity of thorough technical education to the highest industrial and commercial development of a nation, the organization of a national corps of mining engineers has an increased importance; for, as already argued in regard to the influence of a mining college, it would have an immense influence in promoting general scientific education, thereby causing an exact knowledge of the fundamental laws of nature to pervade the people, and giving them a greater power over our vast material resources.

Another great means of increasing the production of the precious metals is the construction of railways across the country, by which prospectors and supplies can be carried into the heart of what are now comparatively unexplored and unknown mineral regions; and by which machinery can be delivered at moderate cost to extensive regions already known, but remaining comparatively dormant for the want of rapid and cheap communication with the centres of supply both east and west.

CHAPTER X.

UNIFICATION OF GOLD AND SILVER COINAGE.

EVILS OF A DIVERSITY IN THE SYSTEMS OF WEIGHTS, MEASURES, AND COINS—ADVANTAGES OF A SIMPLE UNIVERSAL SYSTEM—MOVEMENT FOR MONETARY UNITY—MONETARY CONVENTION—OBSERVATIONS OF MR. BECKWITH, MR. RUGGLES, AND SENATOR SHERMAN ON THE TREATY—PROPOSITIONS BY MR. KENNEDY ADOPTED BY THE COMMITTEE—INTERNATIONAL MONETARY CONFERENCE—ARGUMENT FAVORING A 25-FRANC COIN—PROFESSOR LEVI'S SPEECH—REPORT OF DELEGATION FROM GREAT BRITAIN—REPORT OF ROYAL COMMISSION—VIEWS OF M. CHEVALIER—OPINIONS EXPRESSED IN THE UNITED STATES, AND THE PROPOSED LEGISLATION—CONCLUSION.

The inconveniences and losses arising from the great diversity of systems of weights, measures, and coins among the chief nations of the earth have long been felt and acknowledged, but they are becoming greater and more evident with the constantly increasing facilities for international communication, by which the people and the commodities of remote regions are brought into constant and close contact.

The collections in the department of weights, measures, and coins of the Paris Exposition comprised no less than 36 different systems of weights, based upon 36 different units; 67 different systems of measures, based upon 62 different units; and 35 different standards of gold and silver coin belonging to 18 different monetary systems, based upon 18 different units or measures of value.

ADVANTAGES OF A UNIVERSAL SYSTEM.

The numerous benefits to be derived from a universal system, simple and uniform, in place of this great incongruity and disorder, are not always present to the minds of those who are not occupied with the study of this subject. They may be grouped under the heads of educational, economic and scientific, and commercial. Some of the advantages under each of these heads will be noted.

EDUCATIONAL.

The nature and relations of numbers, together with the systems of weights, measures, and coins, belong to the elementary studies of children in common schools. They are the rudiments or beginnings of knowledge taught by all nations, of every-day use through life, and nothing more generally useful or necessary is subsequently learned even by those who live to be venerable philosophers and statesmen. But however indispensable this part of knowledge is, no common school undertakes to teach more than a part of it. So many systems without any common or connecting principle, or with so many different principles of

evolution, cannot be mastered and retained in the mind without long study and great efforts. It is practically impossible for the great portion of the people to acquire a complete knowledge of the many different systems, and, indeed, it is rare to find those who acquire and retain any permanent knowledge of the systems of any one country. The incoherent and illogical systems are difficult to remember, and the recollection of them becomes dim and uncertain, if not frequently revived.

If the systems of all countries were effectively resolved into one, based upon a decimalized unit, this entire branch of useful knowledge would come within the easy comprehension and reach of every child, and the time required to learn and understand it would be many times less than is now necessary for the incongruous systems of any one country.

ECONOMICAL AND SCIENTIFIC.

The subject becomes more interesting, if not more important, in its connection with the studies of the more advanced student. No one can acquire a thorough, or even a respectable knowledge of political and social science without an easy familiarity with the various systems of weights, measures, and values. The relation of labor to capital, for example, is a subject which at present attracts serious attention in all civilized countries, and an intelligent inquiry involves the study of social and industrial organizations, and the products of labor and skill of many kinds in many countries. These investigations cannot be made useful, comparisons cannot be drawn, and instructive results be attained without a knowledge of the numerous systems.

The science of economics is, for the most part, based upon statistics, and the study of a wide range of statistics is impossible without the use of the keys which unlock them and render them intelligible. But so great is the labor of conversion of numerous systems into the one system of appreciation most familiar and easy to the mind, that foreign statistics, to a very great extent, as they are presented to us, are but approximations and rough estimates embracing many errors. The advantages of a uniform system of measures and values in collecting and diffusing useful knowledge in this department are obvious. They are specially evident to those who have been led to study the Exhibition and learn the lessons taught by the products and statistics of various countries. They will be evident to the readers of the reports on the Exposition. The labor of preparing the present report and of deducing conclusions would have been greatly lessened if the statistics of various countries had been presented in one uniform system of weights and values. Its accuracy and its value would also have been greatly enhanced.

COMMERCIAL.

The numerous and intelligent body of men engaged in commerce in all countries are familiar with the importance of a uniform system of measuring quantities and values.

Commerce is the exchange of products; quantity and value are elements of exchange, and conversions of quantities and values from one system to another, or rather from all systems into the one most habitual to the individual, and in which his appreciations will be most accurate is the endless labor of the merchant. To find the equivalent of one quantity in another system of expressing quantities, or of one value in another monetary system, by conversion, is indeed considerable labor, and if the data or elements of the computation do not previously exist in the mind the attempt will generally end in a resort to formulas or to tables used mechanically and without understanding them. Much time is lost in such computations, and the labor often necessitates the employment of experts at high salaries. All such difficulties operate as hindrances to trade and commercial expansion. Witnesses examined before the Royal Commission stated that the smaller manufacturers and traders of Great Britain are deterred from engaging in foreign transactions by the difficulties attendant upon a diversity of weights and measures, and by the difficulty of calculating exchanges and of remitting small sums from one country to another. Commercial statements, invoices, and lists of prices expressed in the moneys of foreign countries are not readily intelligible in England or in the United States. The adoption of an international uniform monetary system would facilitate and lead to the extension of the money-order system to foreign countries, by which the remittance of small sums could be made at will by the people.

Monetary systems are theories for measuring and computing values, and exist chiefly in matters of finance and account. Coin is but the material expression of parts of those systems, made to pass from hand to hand as measures of value in exchange of products and property, and whenever the monetary systems are harmonized corresponding changes in coin will naturally follow.

Among the most useful things which have become nearly universal among the nations are the numerals of the Arabs and the alphabetic letters of the Romans. A conviction of the benefits of these unities is felt in every industry, every profession and occupation, every branch of science, art, and literature, and a like conviction of the importance and necessity of a universal system of weights, measures, and values is growing in the public mind—in the mind of the whole civilized world;—it spreads with the increase of commerce, the exchange of ideas, and the diffusion of knowledge.

A movement so universal, so peaceful and harmonious, and so desirable, is not likely to cease nor diminish, but to augment in force and velocity. The inequality of the movement hitherto is remarkable. Several countries have entirely abolished their ancient incongruous systems and adopted the metrical-decimal system, which though not perfect is thought by many to be the best that has yet been found.

Numerous other countries have adopted portions of this system, while Great Britain and the United States have legalized the two sections rela-

ting to weights and measures, rendering the use of them permissible. The monetary section makes the slowest progress. To this branch of the subject the attention of the governments participating in the Paris Exhibition was particularly invited by the Emperor of France, which resulted in the formation of an International Committee at Paris in 1866, and an International Conference in 1867.

The following extracts from the reports and documents show the nature of the inquiries and discussions of the Committee and the Conference, the result of their labors, the subsequent action of Congress, the movements in England, and the present state of the subject.

MONETARY UNITY.

The subject of monetary unity is appropriately introduced by Baron de Hock as follows:

"The inconveniences which result from the diversity of monetary systems exceed even those growing out of the diversity of the systems of weights and measures. These are confined to the trouble and loss of time occasioned by the tedious calculations required to pass from one system to the other; still the objects which are weighed or measured continue the same, and may be made use of anywhere. In the case of coin, on the contrary, besides similar calculations of allowance which are necessary, the objects themselves—that is, the coin—lose a portion of their value in passing from one country to another." * * * * *

"It cannot be doubted that the universal unification of coins, by creating a common medium of circulation, constitutes one of the most effective means for the development of general commerce. Such a medium, adopted by every State and individual, saves the loss of time and the trouble caused by the computation to which it is constantly necessary to resort to ascertain the precise value of the different coins; it reduces to a minimum the rate of exchange, that painful burden to commerce; it obviates the losses from exchange of money, to which the arts and manufactures and, not less, travellers are subject; it increases the utility of money, and thereby even its value; it diminishes the needs of circulation, and tends finally to an immediate and radical cure of the crises which spring up in commerce by the accumulation of money at one point and its absence at another.

"The idea of a unification of the coins is so elevated and the purpose so useful that, whenever a favorable situation renders its adoption possible, no progressive people, desirous of entering upon the great and fruitful road of universal commerce, can remain indifferent or reject it, unless from motives of the last importance."[1]

At the preparatory conference relative to the establishment of an international system of measures, weights, and coins, held at the Palace of Industry in Paris, May, 1866, Mr. Le Play stated the object of the meeting as expressed in the notice. During the Exhibition of 1855 a

[1] Extracts from the report of Baron de Hock.

special committee, of which many persons present were members, considered the means of simplifying the operations of international commerce by the adoption of a common system of weights and measures. The conference caused the formation of societies for that especial purpose in many countries, particularly in England. Many of these societies expressed the desire to revive the question at the Universal Exhibition of 1867.

At the second session Mr. Le Play, Commissioner General of the Exhibition, introduced Mr. Leone Levi, professor of King's College, Cambridge, as a delegate of the metrical committee of the British Association for the Advancement of Science, and the International Association for obtaining a uniform decimal system of measures, weights, and coins. Mr. Leone Levi then read the following note:

"Universal exhibitions have shown that much remains to be done to facilitate international communications, and among the chief wants is a common system of measures, weights, and coins.

"This want was greatly felt at the International Exhibition of 1851, and on its close the London Society for the Encouragement of Art, Industry, and Commerce informed the government that it would be well to consult with neighboring nations to see if measures could not be taken to hasten the adoption of a uniform system for the entire world.

"At the Universal Exhibition of Paris in 1855, the juries and committees of the different countries, to the number of two hundred, signed a declaration that one of the best ways to promote industry would be to adopt a universal system of weights and measures.

"At the London Exhibition of 1862 a like report was made by the juries of different kinds, particularly that of chemistry.

"Other international and scientific assemblies, recently held, have expressed the same opinions. The International Statistical Congress, at Brussels in 1853, Paris in 1855, Vienna in 1859, and Berlin in 1863, found great difficulty in reconciling the differences of unity, giving the statistical facts of different countries. Different societies, such as the British Association for the Advancement of Science and the Academy of St. Petersburg, have expressed their opinions upon the advantages to science of uniformity in scientific communications. And finally, after the Paris Exhibition, a special international association was founded to obtain the adoption of a decimal system of measures, weights, and coins. Certain legislative measures of considerable importance have been taken for the same purpose.

"A committee was formed in 1862 in the House of Commons to consider the practicability of a simple and uniform system of weights and measures, to be applied to foreign commerce as well as to domestic trade, and upon its report the legislature declared the metrical system to be a law. The adoption of decimal coins has also been considered by the legislature, and the discussion of the subject has progressed.

"The German states have also found the necessity of unity in their

ights and measures, and after two official conferences at Frankfort in 2 and 1865, they concluded to favor the metrical system. Many er states, such as Spain, Portugal, and Italy, have taken similar ps, and by a treaty relative to coins, recently concluded between ance, Belgium, Switzerland, and Italy, those states have formed a netary union. The United States have lately undertaken the same ject. An inquiry has been instituted, and a bill has been introduced Congress for the adoption of the metrical system. Yet there ains much to be done to complete the work, for there is not only a erence in the national systems of measures, weights, and coins, but re are local and customary measures that embarrass trade and comate international reckonings. The great difficulty is in a practical lication; and the best way to overcome this is to exhibit the measures, ights, and coins in use in different countries at the Universal Exhibin of 1867, and to settle it when the committees having the consideran of the subject meet in Paris. This is suggested as the best plan.

'For these reasons, the International Association to obtain a uniform imal system of measures, weights, and coins, and the metrical comttee of the British Association for the Advancement of Science have tructed me to agree with the Commissioner General upon the means realizing an exhibition, under the auspices of the Commission of the iversal Exhibition for 1867, comprising the following articles:

'1. A collection of weights and measures, their multiples and subltiples, and every legal weight and measure used for any purpose.

'2. Two collections to show both sides of all the current coins of last vernment issue, with specifications of pure metals in them of gold, ver, or copper, and their size, weight, &c.

'3. All official documents on the subject, and particularly every ort of legislative committees in regard to a change in the weights, asures, or coins of the countries.

'The two associations desire, morever, that an international conence be formed for the Exhibition of 1867, composed of competent pers in a scientific, industrial, and commercial point of view, to study objects and documents exhibited, so as to adopt as soon as possible niform decimal system for every country. These conferences might o consider analogous questions of a more scientific nature, and of erest to the progress of civilization."

Mr. Leone Levi added, that the association to obtain a uniform sys of weights and measures, instituted after the London Exhibition of 5, had decided, after much inquiry, to encourage the use of the rical system, because it was founded on nature, and was the most ntific and generally known.

Mr. Mathieu stated that the Bureau of Longitudes, with which he was nected, had printed the bill in English, with the translation and the parative table of weights and measures. If the decimo-metrical sys of weights and measures were adopted as an international system,

the trouble among the scientific men of all countries about the unities of different nations and provinces, in commercial relations, would be avoided. The bill mentioned by Mr. Mathieu, as introduced into the House of Commons, is a happy step toward the desired result.

The following is a translation of the treaty concluded December, 1865, above referred to by Mr. Levi:

MONETARY TREATY BETWEEN FRANCE, BELGIUM, ITALY, AND SWITZERLAND.

ARTICLE 1. Belgium, France, Italy and Switzerland unite to regulate the weight, title, form, and circulation of their gold and silver coins. No change is made for the present, in legislation, relative to copper coins for the four countries.

ART. 2. The high contracting parties bind themselves not to coin, or permit to be coined, any gold other than in pieces of 100, 50, 20, 10, and 5 francs in weight, title, tolerance, and diameter, as follows: All these coins shall be of the fineness or title of .900, with a tolerance of two thousandths above or below the legal standard. The tolerance in weight shall be for the 100 and for the 50 franc pieces, one thousandth above or below; for the 20 and 10 franc pieces, two thousandths; for the 5-franc pieces, three thousandths. The weights and diameters are these:

Gold coins.—100 francs, weight 32.258.06 grams, diameter 35 millimetres; 50 francs, weight 16.129.03 grams, diameter 28 millimetres; 20 francs, weight 6.451.61 grams, diameter 21 millimetres; 10 francs, weight 3.225.80 grams, diameter 19 millimetres; 5 francs, weight 1.612.90 grams, diameter 17 millimetres.

The different states will receive all the above coins when not worn to one-half per cent., or the devices effaced.

ART. 3. The contracting governments bind themselves not to coin, or permit to be coined, silver pieces of 5 francs, except in the following weight, title, tolerance, and diameter: The weight of each 5-franc piece shall be of twenty-five grams; its tolerance in weight, three thousandths; its fineness, .900; its tolerance in title two thousandths; and its diameter thirty-seven millimetres.

They will receive the above pieces at par, unless reduced one per cent. by wear, or the device is worn off.

ART. 4. The high contracting parties will coin hereafter pieces of 2 and 1 franc, 50 and 20 centimes, only under the following conditions of weight, title, tolerance, and diameter: The fineness of these pieces shall be of .835; their tolerance of title, three thousandths; their tolerance of weight, five thousandths for the first two, .007 for the 50-centime piece, and .010 for the 20-centime piece. Their weights and diameters as follows:

Silver coins.—2 francs, weight 10 grams, diameter 27 millimetres; 1 franc, weight 5 grams, diameter 23 millimetres; 50 centimes, weight 2.50 grams, diameter 18 millimetres; 20 centimes, weight 1.00 gram, diameter 16 millimetres.

› above pieces shall be recoined by the respective governments reduced by wear, or when their devices shall have become effaced.

r. 5. Pieces of 2 and 1 franc and of 50 and 20 centimes of a differ›inage from the above, shall be withdrawn from circulation by the January, 1869. This term is extended for the pieces of 2 and 1 issued in Switzerland, by the law of January, 1860.

r. 6. The silver coins authorized in article 4 shall be a legal tender ;ely to the sum of fifty francs. The nation issuing them shall e them in any amount.

r. 7. The public banks of each of the four countries will receive the of article 4, to the sum of 100 francs, in payment to said banks. overnments of Belgium, France, and Italy will receive the Swiss 2 franc pieces of 1860, under the same conditions, as equivalent to ›ins of article 4, and under the reservation relative to wear.

r. 8. Each of the contracting governments binds itself to receive ɔanks or individuals the small coins they have issued, and return [uivalent in current coin, (gold or 5-franc silver pieces,) provided ım presented be not less than 100 francs. This obligation shall d two years beyond the expiration of this treaty.

r. 9. The high contracting parties agree not to issue a greater ıt of these 2 and 1 franc, 50 and 20 centime pieces of Article 4, than ıncs for each inhabitant. The amount thus fixed in accordance he last census and the presumed increase of population is fixed at—

	Francs.
›elgium	32,000,000
'rance	239,000,000
:aly	141,000,000
witzerland	17,000,000

:lusive of the above sums the different governments can issue of already in circulation in the following proportions: France, in 50 0-centime pieces, by the law of May 25, 1864, 16,000,000; Italy, and 1 franc, 50 and 20 centime pieces, by the law of August 24, 100,000,000; Switzerland, in 2 and 1 franc pieces, by the law of ıry 31, 1860, 10,500,000.

r. 10. Hereafter the date of issue shall be stamped on all the gold lver coins issued by the four governments.

r. 11. The contracting governments shall give the quantity of their of gold and silver coins every year, the amount collected for meltnd make a general annual report of the proceedings. They shall se give notice of important facts in regard to the circulation of issues.

r. 12. Any other nation can join the present convention by accept- obligations and adopting the monetary system of the Union in 1 to gold and silver coins.

r. 13. The execution of the reciprocal engagements contained in

the present convention is left to the high contracting powers, who bind themselves to pass laws for the purpose as soon as possible.

ART. 14. The present convention shall remain in force till the 1st of January, 1880. If it be not repealed a year before the expiration of that term, it shall remain in force for an additional period of 15 years, and so on, until repealed.

ART. 15. The present convention shall be ratified, and the ratifications exchanged at Paris, within six months, or less time, if possible.

EXTRACTS FROM THE REPORT OF THE COMMITTEE, APPOINTED IN FRANCE, TO EXAMINE A BILL RELATIVE TO THE TREATY.

A monetary disturbance has existed in France for several years, caused by a variety of circumstances.

Our monetary system has two standards for its basis:

In the first place, the silver franc, of the weight of five grams, and of .900 fineness, is the monetary unity by the law of the 7 Germinal, year XI; and the 20-franc gold piece, weighing 6.451, of .900 fineness, by article six of the same law, 7 Germinal, year XI, is the legal equivalent of the franc multiplied by 20. That law, fixing our present monetary system, reckoned a kilogram of pure silver at 222 francs 22 centimes, and one of pure gold at 3.444 francs 44 centimes; which makes the difference in value of the two metals in the proportion of 1 to 15½. Can this relation remain fixed, or is it modified by circumstances? It has been stationary for nearly one-half a century. Silver was the usual money; gold, in small quantities, was at a premium. About the year 1835, by reason of improvement in refining, the 5-franc silver pieces of the earliest coinage were hunted up and melted to extract the gold they contained. Yet the relation between silver and gold continued the same. But the discoveries of gold in Russia, California, and Australia, between the years 1846 and 1850, brought gold abundantly into the European markets. The metal fell in value, and 5-franc silver pieces were more than ever sought for. The government took note of this, and a committee was appointed in 1850 to investigate it. Thiers was its chairman. The political troubles of the time prevented action. The difference of value of the two metals increased, and speculators began to buy up the smaller silver coins. Two other circumstances hastened the disappearance of silver from circulation: the loss of our silk-worms and the American civil war compelled us to buy silk and cotton from the east to keep our factories going; and, as silver is more valued in those distant lands, we had to pay for the imports in silver, having no produce to exchange for them. And there was yet another reason to make silver more valuable: the improvement in the circumstances of our laboring classes increased the necessity of small coin for change. A committee in 1857, and another in 1861, were commissioned to investigate the subject. It was shown that the yield of silver and gold from the New World, from the time of its discovery to 1846, was as two to one; whereas the yield now was three of

gold to one of silver. It was also shown that silver 5-franc pieces had almost entirely passed out of circulation; that out of 214,463,000 francs in small coin, issued since the year XI up to 1864, there remained 160,000,000 in circulation; and that the last issues of 43,000,000, made since January 1, 1856, were immediately absorbed by speculation. The fact was serious.

To increase the weight or fineness of our gold coins, in order to restore the equilibrium of value between the two monetary standards, was almost impossible, on account of the vast amount of gold in circulation. It would have been a great expense to the State, without considering other inconveniences. The greatest want was of small change. Ten and 5-franc gold pieces had supplied the place of silver 5-franc pieces. The bill of May 25, 1864, proposed to withdraw all the 2, 1, ½, and ¼ franc pieces of .900 fineness from circulation, and to issue the same coins of .835 fineness. These new pieces, considered merely as change money, were to be taken only in amounts of 20 francs and less, between private individuals, but good for any amount in the public banks. The right of making and circulating was reserved to the state. This seemed to be the proper remedy, as speculation would not disturb the alloyed small coin. The legislature liked the plan, but modified it by issuing only 50 and 20 centime pieces of .835 fineness. The reasons for this are given in Mr. Gouin's report. There were two dominant ideas: one was a determination not to alter the franc of .900, the expression of our monetary unity; the other was to see if the alloy of .835 would be acceptable to the people. This was wise; it answered for the present, and reserved something for the future; and so the bill was made a law.

A two years' trial has shown that the new coins of .835 have been welcomed by the public. Speculators have pounced upon the 2 and 1 franc pieces and bought them out of circulation, except those worn so much there is nothing to be made out of them.

Now is the time to resume the labor of 1864, and satisfy the public that complain of the scarcity of change, and such is the object of the bill now submitted to your consideration. It proposes to extend the law of May 23, 1864, to the 1 and 2 franc silver pieces. The proposition is sustained by a convention concluded with the three nations nearest to France that have adopted the French monetary system. The advantages of a single monetary system for all nations need no discussion. Besides the convenience to border countries and travellers, it facilitates commerce by giving a common and certain measure to currency. It is a consequence of free trade and that instinct that prompts people to unite their interests by commerce and industry. We hope soon to see uniformity of weights everywhere, and we believe France will set the first example to all other nations.

We have therefore given, as a principle to be examined in detail, our complete approbation to the convention, and the bill which is the result of it.

A question of another nature arose in the committee: As the two monetary standards have long been a source of annoyance, why did we not adopt gold as the only standard, like England and many other nations, and thus settle it definitely at once? The committee was not in favor of it. We certainly cannot say what the future may have in store for us, but nobody can say but what the measure may be soon adopted; it is too soon yet. Though theory and logic may be for a single standard, facts show that the double standard offers great advantages in practice. The two help each other, and in times of crises one serves as a balance to the other. The use of both metals, moreover, facilitates our commercial relations with other countries, by allowing our merchants a choice of the coin best suited to the stranger. Does a difference of the value between the two metals, of late years, give a sufficient cause for such a radical reform? If silver is preferred to-day, the preference may change by the discovery of vast silver mines, or a great reflux of silver from the East by reason of the sale of our manufactures in those countries. The proposed law prudently confines itself to present necessities, without pretending to look for the future.

The committee, in all its deliberations, has kept one idea in view: By the declaration preliminary to the law of 7 Germinal, year XI, the franc of five grams weight and .900 fineness is the point of departure, the foundation of our entire monetary system. As soon as it is reduced to .835 it disappears, and would not its reduction be in violation of the above law? It might also cause some confusion in our foreign trade.

The objection was fully considered, if the legal franc ceased to exist, would the fact be due to the new law? The 1-franc pieces are gradually disappearing, owing to the difference of value between gold and silver. The 1-franc pieces now in circulation are so much worn they hardly have the intrinsic value of the new .835 pieces. True, the government could coin more of .900, but speculation would soon remove them from circulation. The new law, then, does not cause the harm. It existed before, and the law alleviates it. It is not just to say the franc will have ceased to exist in its material expression when the new law comes into force. It will still preserve its expression in the 5-franc silver piece, its fifth multiple, which is retained in our monetary system, though becoming scarce, and circulates freely in the three countries that joined France in the convention of the 23d December, 1865.

However, as legislation ought to be precise in these matters, we have endeavored to make the text of the new law as plain as possible by introducing two amendments. The first calls the 2 and 1 franc the 50 and 20 centime pieces change-money, which is their true character. The second declares it "no violation of the law of 7 Germinal, year XI, which makes the franc the basis of the French monetary system." Thus, all doubts and false interpretations are removed. The new 1-franc piece, of less value and of restricted circulation, is created by necessity. The old franc is retained as money of account, and as the normal measure of gold and silver, in conformity to law.

OBSERVATIONS BY MR. BECKWITH ON THE TREATY.

Mr. Beckwith, the United States commissioner general to the Paris Exposition, in a letter to the Hon. William H. Seward, Secretary of State, under date of Paris, July 17, 1866, makes the following observations upon the treaty:

"It results from these proceedings that a uniform system of coinage is established in the four countries named—uniform as regards the unit, the metallic standards, and the value of the pieces to be coined. Each country retains the double standard of gold and silver with the relative value of 1 to 15½.

"The composition of gold coin remains in the proportion ($\frac{9}{10}$) nine parts of fine gold to one of alloy, and the coinage of gold is restricted to pieces of the value of 100 francs, 50 francs, 20 francs, 10 francs, and 5 francs.

"The composition of the silver 5-franc pieces remains in the proportion of ($\frac{9}{10}$) nine parts fine silver to one of alloy; but the composition of silver coin of smaller values is reduced from $\frac{9}{10}$ to ($\frac{835}{1000}$) 835 parts fine silver to 165 parts of alloy, a reduction in value of about 7 per cent.

"The coinage of this class is restricted to pieces of the value of 2 francs, 1 franc, 50 centimes, and 20 centimes, and limited in amount to six francs per head of population, which should give about 32,000,000 francs for Belgium, 239,000,000 francs for France, 141,000,000 francs for Italy, and 17,000,000 francs for Switzerland.

"This inferior money is a legal tender between individuals to the amount of 50 francs in a single payment, and receivable for dues to the government without limit. It follows from these measures that the unit of the monetary system (1 franc of the standard of $\frac{9}{10}$) will cease to be coined; but it retains a nominal existence; it remains money of account and is still the unit of the monetary system, and the measure of all values, though it has no material existence except in its multiples, of which the quintuple or 5-franc piece is the smallest coin.

"The reduction in the value of small silver coin brings the standard of this class in harmony, I believe, with the small silver coin of the United States, under the law of 1850. If this be so, the metallic standards both of the gold and silver coin of the United States are now in harmony with those of the four countries named, and the standards being in harmony and the systems all decimal, it only remains to harmonize the coin in order to produce reciprocal circulation. For this purpose a common unit does not appear to me to be necessary.

"However numerous the monetary systems and different their units, if they are all decimal and their standards of coin alike, it is only necessary that the pieces coined in each be in harmony with their own system to produce the uniformity required for circulation in common, provided that the unit of each monetary system be capable of expression in the multiples and sub-multiples of the other systems.

These approximations are much easier of attainment than unity. No

substitution of the units of one country for those of other countries need be made; very slight modifications of existing units and standards, with decimalization, would produce a common measure of values, and assimilate all the principal monetary systems in the manner required for the reciprocal circulation of coin. Modification is the easiest method of reforms.

"Coining a unit of one system would then be of necessity coining at the same time a multiple or sub-multiple of the unit of all the other systems, and the pieces struck in conformity with each system would bear the same relations to the coins of the other systems that the several pieces of any one system bear to each other.

"Neither is it of moment what names may be given to coins in different countries, nor how numerous their varieties or various their values, because they will all be aliquot decimal parts of harmonious systems, the coin of each being referable to its own unit, and referable with equal facility to the multiples or sub-multiples of the units of the other systems.

"In like manner a small change in the standard of British gold coin from $\frac{916}{1000}$ to $\frac{900}{1000}$ would complete the unity of standards of gold coin, since the whole civilized world nearly, except England, has adopted the standard of $\frac{9}{10}$ fine.

"Our gold dollar, for example, is equal to 517 French centimes; a reduction of 17 centimes ($3\frac{1}{2}$ c.) would leave it an exact multiple of the French unit, or franc, and the equivalent of five francs. A reduction of 12 centimes ($2\frac{1}{2}$ c.) in the value of the British unit or sovereign would leave it a multiple of the franc, and the equivalent of 25 francs, and consequently a multiple of the dollar, and the equivalent of five dollars.

"Modifications of this kind are not difficult: they are common. They produce little inconvenience to the public; they do not disturb business, nor trench upon prejudices; they come into use almost imperceptibly, and in this case would leave the unit of each national system—those great traditional measures of value so deeply rooted in every mind—in effect undisturbed, with their various mottoes, emblems, and effigies, and with all the impregnable habits of thought, and even the superstitions which cluster around them.

"The tenacity with which nations and peoples hold to their ancient measures of value is remarkable, and whether it springs from a principle or a prejudice, it is a fact so firmly fixed that it is difficult to eradicate: nor is it worth the labor, or even desirable, if a common language of values can be otherwise attained."

OPINION OF MR. S. B. RUGGLES.

Before the meetings of the international committee for examining the question of a uniform coin had commenced, Mr. Ruggles, delegate from the United States, was enabled, through the introduction of Monsieur Michel Chevalier, senator of France, who took much interest in the subject, to confer fully with M. de Parieu, vice-president of the *conseil d'etat*,

nd one of the two representatives of France in negotiating the monetary onvention of 23d December, 1865. He suggested to M. de Parieu the xpediency, and, indeed, urged the necessity, of modifying that portion f the treaty which prohibits either of the four nations who had made it rom issuing gold coin of any denominations but those of 5, 10, 20, 50, nd 100 francs. "This necessity is obvious at once from the fact that he gold coin most in ordinary use in the United States is the half-eagle f $5, which, with a slight diminution, could be readily reduced to 25 rancs in value. This coin, when exported to France, in order to be eadily and generally current, must there find itself side by side with ome well-known French coin of like weight, diameter, and value." The ropriety of this suggestion M. de Parieu not only admitted at once, but xpressed his belief that the treaty might be modified by the four nations, 1 thirty days, to meet the necessities in this respect of the United States.

Similar suggestions were made to M. Rouher, chief minister of state, nd his attention was directed to the fact that the Congress of the United tates, in recently authorizing the issue of one of our smaller coins, had iven to it a precisely even metric weight and metric diameter, (being five *rams* in weight and two *centimetres* in diameter,) thereby scattering idely through the pockets of the American people the means of studyng the metric system by specimens of the *metre* and its derivative the *ram*, constantly visible.

Mr. Ruggles afterward suggested to the Emperor that France could oin a piece of gold of 25 francs, to circulate side by side on terms f absolute equality with the half-eagle of the United States and the overeign, or pound sterling, of Great Britain, when reduced, as they eadily might be, precisely to the value of 25 francs. The Emperor then sked, "Will not a French coin of 25 francs impair the symmetry of the 'rench decimal system?" To which it was answered, "No more than ; is affected, if at all, by the existing gold coin of five francs;" that it ras only the silver coins of France which were of even metric weight, rhile every one of its gold coins, without exception, represented unequal ractions of the metre.

It was also stated to the Emperor that an eminent American statesnan, Mr. Sherman, senator from Ohio, chairman of the Finance Comnittee of the Senate of the United States, and recently in Paris, had ritten an important and interesting letter, expressing his opinion that he gold dollar of the United States ought to be and readily might be educed by Congress, in weight and value, to correspond with the gold ive-franc piece of France.

The letter of Mr. Sherman, addressed to Mr. Ruggles, dated the 18th fay, 1867, is as follows:

LETTER FROM SENATOR SHERMAN TO MR. RUGGLES.

"MY DEAR SIR: Your note of yesterday, inquiring whether Congress rould probably, in future coinage, make our gold dollar conform in value o the gold five-franc piece, has been received.

"There has been so little discussion in Congress upon the subject, that I cannot base my opinion upon anything said or done there.

"The subject has, however, excited the attention of several important commercial bodies in the United States, and the time is now so favorable, that I feel quite sure that Congress will adopt any practical measure that will secure to the commercial world a uniform standard of value and exchange.

"The only question will be, how this can be accomplished.

"The treaty of December 23, 1865, between France, Italy, Belgium, and Switzerland, and the probable acquiescence in that treaty by Prussia, has laid the foundation for such a standard. If Great Britain will reduce the value of her sovereign two pence, and the United States will reduce the value of her dollar something over three cents, we then have a coinage in the franc, dollar, and sovereign, easily computed, and which will readily pass in all countries; the dollar as five francs, and the sovereign as 25 francs.

"This will put an end to the loss and intricacies of exchange and discount.

"Our gold dollar is certainly as good a unit of value as the franc; and so the English think of their pound sterling. These coins are now exchangeable only at a considerable loss, and this exchange is a profit only to brokers and bankers. Surely each commercial nation should be willing to yield a little to secure a gold coin of equal value, weight, and diameter, from whatever mint it may have been issued.

"As the gold five-franc piece is now in use by over 60,000,000 of people, of several different nationalities, and is of convenient form and size, it may well be adopted by other nations as the common standard of value; leaving to each nation to regulate the divisions of this unit in silver coin or tokens.

"If this is done, France will surely abandon the impossible effort of making two standards of value. Gold coins will answer all the purposes of European commerce. A common gold standard will regulate silver coinage, of which the United States will furnish the greater part, especially for the Chinese trade.

"I have thought a good deal of how the object you propose may be most readily accomplished. It is clear that the United States cannot become a party to the treaty referred to. They could not agree upon the silver standard; nor could we limit the amount of our coinage, as proposed by the treaty. The United States is so large in extent, is so sparsely populated, and the price of labor is so much higher than in Europe, that we require more currency *per capita*. We now produce the larger part of the gold and silver of the world, and cannot limit our coinage, except by the wants of our people and the demands of commerce.

"Congress alone can change the value of our coin. I see no object in negotiating with other powers on the subject. As coin is not now in general circulation with us, we can readily fix by law the size, weight

and measure of future issues. It is not worth while to negotiate about that which we can do without negotiation, and we do not wish to limit ourselves by treaty restrictions.

"In England, many persons of influence, and different chambers of commerce are earnestly in favor of the proposed change in their coinage. The change is so slight with them that an enlightened self-interest will soon induce them to make it; especially if we make the greater change in our coinage. We will have some difficulty in adjusting existing contracts with the new dollar; but as contracts are now based upon the fluctuating value of paper money, even the reduced dollar in coin will be of more purchasable value than our currency.

"We can easily adjust the reduction with the public creditors in the payment or conversion of their securities, while private creditors might be authorized to recover upon the old standard. All these are matters of detail to which I hope the commission will direct their attention.

"And now, my dear sir, allow me to say in conclusion that I heartily sympathize with you and others in your efforts to secure the adoption of the metrical system of weights and measures.

"The tendency of the age is to break down all needless restrictions upon social and commercial intercourse. Nations are now as much akin to each other as provinces were of old. Prejudices disappear by contact. People of different nations learn to respect each other as they find that their differences are the effect of social and local custom not founded upon good reasons. I trust that the Industrial Commission will enable the world to compute the value of all productions by the same standard, to measure by the same yard or metre, and weigh by the same scales.

"Such a result would be of greater value than the usual employments of diplomatists and statesmen."

This letter was received by the committee with lively interest, and with the approbation of the Imperial Commission was ordered to be published in French and English.

MR. KENNEDY'S PROPOSITIONS ADOPTED BY THE COMMITTEE.

Previously to the 23d of March the international committee had taken no steps to discuss the subject of uniform weights, measures, and coins, their attention up to that time having been mainly given to the erection and arrangement of the pavilion in the interior garden of the Exposition for the actual exhibition and comparison of the weights, measures, and coins of the respective nations represented in this universal concourse.

The subject of a uniform coin did not actually come into discussion, either in the international committee or the sub-commission on coins, until early in the month of May.

On the 8th of June Hon. John P. Kennedy, who had been added to the committee, submitted seven resolutions, which, with the remarks introducing them, were subsequently adopted by the committee in sub-

stance, and almost literally, and were made the basis of its report. These resolutions, as adopted by the committee, translated, are as follows:[1]

"The committee, considering that the adoption of a uniform system of coins presents advantages of convenience and economy in the regulation of international exchanges so evident, that it commends itself to every enlightened government; considering, furthermore, that such a measure cannot be realized without the sacrifice by many peoples of their old and customary instruments of trade, and that their interest requires this change should be gradual and continuous, and therefore that the first steps of the transformation should be as simple as possible and disembarrassed of all incidental complication, therefore submits the following propositions:

"1st. The first condition to be fulfilled is the adoption of an identical unity in the issue of their gold coins by the different governments interested in the question.

"2d. It is desirable that such coins should everywhere be struck at the standard of nine-tenths.

"3d. It is desirable that every government should introduce among its gold coins at least one piece of the same value as a piece in use among other interested governments, so that there may be a point of common contact in all the systems, and therefore each nation should endeavor gradually to assimilate its monetary system with that which may be chosen as a uniform basis.

"4th. The series of gold coins now used in France having been adopted by a large portion of the people in Europe, is recommended as a basis of the uniform system desired.

"5th. Considering that the most important of the monetary units, by a fortunate and accidental circumstance, can be adapted to the French gold piece of five francs, by slight changes, that piece would be most suitable as a basis for a monetary system; and coins struck upon that basis would become the multiples of that unity as soon as the convenience of interested nations would permit.

"6th. It is desirable that the different governments determine that the coins struck by each nation, in conformity with the uniform system proposed and agreed upon, should pass as legal tenders in all those countries.

"7th. It is very desirable that the system of two different monetary standards should be abolished wherever it still exists.

"8th. It is very desirable that the system of decimal numeration should be universally adopted, and that the coins of all nations should be of the same standard and form.

"9th. It is desirable that governments should agree to adopt common measures of control, so as to secure the integrity of coins in their issue and in their circulation."

The "international committee on uniform weights and measures and

[1] *Vide* Rapports et Procès-verbaux Comité des Poids et Mesures et des Monnaies, p. 18, and for the resolutions submitted by Mr. Kennedy, p. 49.

oins," charged with the preliminary study of the question, took into onsideration not only what is theoretically and abstractly possible, but 'hat is commercially and financially practicable. The subsequent duty f fixing a common coin as the monetary unit required an international onference, composed of representatives duly accredited from the various nations, and vested with diplomatic powers.

INTERNATIONAL MONETARY CONFERENCE.

The delegates to the monetary convention had expressed in the name f their governments a desire to see the union, as yet restricted to four ountries, become the germ of a union more extended, and of the estabshment of a general monetary circulation among all civilized states.

A copy of the text of the treaty, or "monetary convention," was forarded by the French government to the government of the United tates, with an invitation to participate in an international monetary onference to be held in Paris in June, 1867, during the progress of the niversal Exhibition. The object of this conference was declared to be call out an interchange of views and discussion of principles; to seek for e basis of ulterior negotiations.

In accordance with this invitation the Hon. Samuel B. Ruggles, who 'as then in Paris as United States commissioner to the Universal Expoition, was specially authorized to represent the government of the nited States in the conference. The proceedings of this conference, nd of the "preliminary international committee" on uniformity of coinge, organized by the imperial commission of the Universal Exposition, 'ere fully reported from time to time by Mr. Ruggles to the State Department, and were followed by a very elaborate and interesting report upon he whole subject. This report, in addition to a full discussion of montary unification, contains valuable statistics and information upon the mount of gold and silver in circulation; upon the coinage of the prinipal nations, and upon the weights and fineness of gold and silver coins nd the relative value of gold and silver. Extended extracts from the eports have, therefore, been made.

On the 17th of June, 1867, the invited nations, 19 in number, responded y sending 32 duly accredited delegates, and the International Monetary onference met for the first time at the hotel of the Department of 'oreign Affairs, under the presidency of his excellency Marquis de foustier, the minister for foreign affairs. There were eight successive essions, terminating on the 6th of July, 1867, at which the whole subct was discussed at length, and full reports and arguments were presented.[1]

[1] The proceedings of the conference were fully reported in an official volume, entitled *nférence Monétaire Internationale; Procès-verbaux. Paris: Imprimerie Imperiale*, 1867. translation accompanied by translations of other documents and letters relating to this bject was transmitted to Congress, and was published, (*vide* Ex. Doc. No. 14, 40th Conss, 2d session.)

In opening the labors of the conference, the president said:

"The approximations which the late commercial reforms have wrought between the economic interests of nations ought to result in causing to be appreciated more earnestly than in past time the advantages which would be derived from the unification of coinages. To substitute instead of the variety of monetary types actually in use, metallic coins struck in accordance with uniform regulations, and placed beyond any variations of exchange, would, in effect, be to remove one of the most serious obstacles to the development of international relations. Thus, when in 1865 the delegates of France, Belgium, Italy, and Switzerland had succeeded in forming between those countries a real monetary union, the thought of a more extended association naturally presented itself to their intelligence; thence came the right of accession opened to other countries by a special clause in the convention of December 23, 1865; thence the wish put forth by the commissioners, that studies should be undertaken, in concert, among all civilized states on the question of uniformity of coinage.

"No period could be more favorable to the realization of this wish than that of the Universal Exposition; the government of the Emperor hastened to avail of it, and the acceptance which various governments have pleased to extend to these overtures has shown that the importance of the problem to be solved was universally recognized.

"The dispositions thus manifested from the outset are so much the more precious, as it was impossible to dissemble the difficulties of the task which the members of the conference have to accomplish. Those difficulties are of diverse nature, and to remove them it is important, beyond all, that each state, in view of the great interest it seeks to satisfy, should seek, without exclusive opinions, the best solution.

"The French government is, moreover, pleased, gentlemen, to recognize in the choice of yourselves, on the part of your government, a fresh pledge of the solicitude which, abroad as well as in France, is entertained upon the question submitted to the conference. A study of such delicacy and so complex could not be confided to an assemblage which could present a more complete combination of knowledge required either in the conduct of great affairs, in the management of important financial institutions, or in technical operations."

* * * * * *

Reports and written arguments were presented during the sessions by M. de Parieu, Baron de Hock, and Mr. Samuel B. Ruggles. Extracts from these reports are embodied in these pages.

PLAN OF MONETARY UNIFICATION AGREED TO BY THE CONFERENCE.

The following are the general features of the plan of monetary unification agreed to by the conference:

1. A single standard, exclusively of gold.
2. Coins of equal weight and diameter.
3. Of equal quality, (or *titre,)* nine-tenths fine.

4. The weight of the present five-franc gold piece, 1612.90 milligrams,) be the unit, with its multiples. (The weight of the present gold dolur of the United States is 1671.50 milligrams. The value of the excess ver the five-franc gold piece, 58.60 milligrams, slightly exceeds 3½ cents. 'o encourage the reduction of the United States half-eagle and of the ritish sovereign to the value and weight of 25 francs, the conference ecommended the issue of a new coin of that weight and value by 'rance and the other gold-coining nations. The reduction in value of ie half-eagle would slightly exceed 17½ cents; in the sovereign, 4 cents.)

5. The coins of each nation to continue to bear the names and emlems preferred by each, but to be legal tenders, public and private, ı all.

The conference further requested the government of France to invite ıe different nations to answer, by the 15th of February, 1868, whether ıey would unite in placing their respective monetary systems on the asis indicated by the conference, as above stated; and after receiving ıeir answers, to convene, if necessary, a new or further conference.

A further resolution of the conference recommends that the measures ' unification which the nations may mutually adopt be completed, as ır as practicable, by diplomatic conventions.

By these proceedings and official reports, the whole question of mon:ary unification was distinctly presented for consideration and decision › the governmental authorities of the United States, executive and gislative.

By a communication from the Department of State of the 30th May, mpowering Mr. Ruggles to represent the United States in the conferace, he was directed not only to report its proceedings and conclusions, ut to add such "observations as might seem to be useful." He there›re submitted an additional report, mainly explanatory of the grounds aken in the conference in behalf of the United States, but embodying tatements which may possibly facilitate to some extent the examination f the subject by the government and others.

EXTRACTS FROM THE REPORTS OF MR. RUGGLES.

"All the independent sovereignties of Europe, with the possible exception of some small portions of northern Germany, were represented in he conference by delegates duly accredited. The delegates from Prusia appear on the roll as representing that power only, but from the fact f their repeatedly abstaining from voting on certain questions in the onference 'without the consent of the Confederated States,' they were ractically considered as representing all the states and communities of orthern Germany now confederated with Prussia. There were no sepaate delegates from the kingdom of Saxony, or either of the Hanseatic ities of Hamburg, Bremen, Lubec, or Frankfort. There were separate elegates from Baden, Wurtemberg, and Bavaria. None of the nations 'est of the Atlantic were represented, except the United States of merica.

"The nations appearing by delegates in the conference were entered alphabetically on the roll, in which order they voted. A copy of the roll is hereto subjoined. Including Sweden and Norway as one, they were nineteen in number, being: Austria, Baden, Bavaria, Belgium, Denmark, Espagne, (Spain,) Etats Unis, (United States of America,) France, Great Britain, Greece, Italy, Pays Bas, (Holland,) Portugal, Prussia, Russia, Sweden and Norway, Switzerland, Turkey, Wurtemberg.

"Their aggregate population, European and American, a little exceeds 320,000,000. The population of the dependencies of these nations in Asia is estimated at 190,000,000. There were no separate delegates from any portion of the West or the East Indies, not even from Australia, which had been separately and conspicuously represented in the International Statistical Congress, at London, in 1860, and which still plays a part so important in furnishing gold to British India and other oriental countries.

"It is, indeed, specially noticeable in the reported discussions of the conference how little account was made of that populous quarter of the globe in estimating the world-wide advantages of a common money; and this omission has become more worthy of remark from the circumstance that information reached Paris, soon after the adjournment of the conference, that measures were in actual progress, at Pekin, for striking, for the use of the immense population of China, coins of the weight and value respectively of 20 francs, of 5 francs, and of 1 franc, bearing on their face the head of the Chinese Emperor, thereby assimilating the money of the Celestial Empire to that of Europe.

"The interesting fact is stated in a historical report (recently published by a member of the British embassy) of the money of Japan, that it possesses a coinage of gold and silver in some essential features resembling that of France, particularly in a double standard, under which the ratio of silver to gold is fixed at 13½ to 1.

"It appears that, in ignorance of the actual relative values of the two metals in our Atlantic world, (of 15 or 16 to 1,) these Asiatics had fixed the ratio at only 4 to 1, which great exaggeration of silver they were furthermore induced to continue by a treaty in 1858, under which they were rapidly despoiled of their gold in large quantities by some of the traders from Christian nations. The partial correction of the mistake in 1860, by raising the ratio to 13½ to 1, (if any ratio fixed by governmental regulation be admissible at all,) shows an advance of intelligence in this distant region, inspiring the hope that, in due time, at least a portion of eastern Asia may be brought within a world-embracing and world-protecting belt of monetary unification.

"The British colonies in continental North America, recently consolidated by imperial authority in the 'Dominion' of Canada, were represented in the conference only as a part of the British empire by the delegates from the United Kingdom. That young but rising power, though remaining in form a colonial dependency, now possesses, under the

st section of the act of the imperial Parliament of the 29th of March, 37, the sovereign and 'exclusive legislative authority' to regulate its n 'currency and coinage,' already much assimilated to the decimal stem of the United States. The deep interest in the success of the nding measure of unification manifested by Mr. Bouchette and other elligent Canadian officials, who were at Paris to superintend the exhi- ion of the products of their country, affords ground for believing that e general conclusions, and the basis now proposed by the conference, ll command the ready assent and co-operation of that active and inter- ing portion of the North American continent.

"Of the Mohammedan nations, the Ottoman empire was represented in e conference by his Excellency Djemil Pacha, its ambassador extra- linary and plenipotentiary to the court of France. With him was sociated the Colonel Essad Bey, the military director of the Ottoman ademy in Paris, who had, moreover, officially represented his govern- nt in the preliminary 'international committee on uniform weights d measures and coins,' in which body he had manifested a marked sire that the proposed monetary reform might include the coinage of rkey. At a later stage of the conference his Excellency Mihran-Bey- z, member of the Grand Council of Justice and director of the mint Constantinople, whose early arrival had been unexpectedly retarded, peared and took his seat as a member.

"The ambassador to France from Persia, (sometimes called the 'rance of Asia,') a personage of singular intelligence, had also mani- sted a lively interest in the proposed monetary reform, but had been liged to leave Paris on the eve of the first meeting of the conference. is worthy of notice that the standard of the gold coin of Persia is .900 e, being the same as that of the United States, while that of Turkey still higher, being .915 fine. The principal gold piece of Persia is orth 22.27 francs; that of Turkey 22.48 francs.

"The clear and comprehensive vision of the far-seeing advocates in urope of monetary unification has fully discerned the grandeur of unit- g the two hemispheres in one common civilization. M. Esquiron de arieu, vice-president of the conseil d'etat of France, who presided with ninent wisdom and dignity over the conference at several of its most portant meetings, declares, in one of his learned and luminous mone- ry essays, now lighting the path of the Older World, that 'a monetary tion of western Europe and the transatlantic nations would possess an contestable importance. Above all,' he adds, 'it would produce a and moral effect.' As if foreseeing with the eye of prophecy a conti- ntal, if not a world-wide 'solidarity' for the 'dollar,' founded histori- lly on the past, he adds, 'the Americans can never regard their dollar a merely national coin, after having borrowed it from their neighbor- g Spanish colonists.'

"As a matter of historic truth, Spain itself had borrowed the 'dollar' om Austria, during their union under the common empire of Charles

the Fifth. The 'Joachim's *thaler*,' first coined in the silver mines of the Bohemian *valley* of St. Joachim, (or James,) is the great ancestor, in fact, of the American dollar. In purity of origin and length of lineage it must surely suffice to satisfy the most aristocratic tastes of modern Europe.

"Nor is there any such diversity in the coinages of the Central and South American nations, or differences from those of Europe or the United States, as to render the task of unification seriously difficult on their part. The gold doubloon or *doublon* (sometimes denominated in the monetary tables the *quadruple pistole*) of New Granada, of Bolivia, and of Chili, are each .870 parts fine; that of Mexico, .870.5; that of Peru, .868. The French 'Annuaire' reports that of Ecuador at .875. Their money values, in the existing dollars of the United States, are reported by the director of the mint of the United States as being, for New Granada, $15.61; for Chili and Bolivia, $15.59; for Peru, $15.58; for Mexico, $15.52.

"The full and perfect measure of Hispano-American unification would be attained by increasing the weight of all these doubloons to 100 francs, which would render them at once equivalent to the double-eagle (or $20) of the United States, or to four British sovereigns, (when reduced as now proposed,) and current, without recoinage, brokerage, or other impediment, throughout the world. This enlarged doubloon divided into halves and quarters would supply for the people of Spanish America one convenient coin, equivalent to 50 francs, or an eagle of the United States, or two British sovereigns; and another coin, equivalent to 25 francs, or a United States half-eagle, or one British sovereign. Mexico has already a gold coin of 20 *pesos*, finely executed; and Peru has a gold piece of 20 *soles*; each of them being nearly equivalent to the double-eagle.

"The 20 *mil-réis* of Brazil, now worth $10.85, would probably be conformed to the plan proposed for Portugal, the parent country, by the Count d'Avila, her experienced and able delegate in the conference, by the issue of a gold coin equivalent to 25 francs, with such subdivisions and multiples as convenience might require."

ARGUMENT FAVORING A TWENTY-FIVE-FRANC COIN.

At the sixth sitting of the conference, on the 28th of June, Mr. Ruggles presented a written argument in favor of the issue of a 25-franc gold piece by France. He says:

"If it be objected that such a piece, not containing an even number of grams, would impair the symmetry of the metric system, it need only be stated that France has not, and never has had, a gold coin containing an even number of grams. The relation in value between silver and gold having been fixed by law at 15½ to 1, it became impossible to establish a decimal relation between the two metals; or, in other words, between the number of francs which represent only silver, and the number of grams in the coins of gold. This legal relation of 15½ to 1 is

elf fractional, and must be doubled and carried to $\frac{31}{2}$ to make even mbers.

'The franc is simply a monetary word, which expresses five grams of ver nine-tenths fine. It is the French monetary unity. Gold having alue of 15½ times greater than silver, it requires 15½ francs each of 5 ms of silver (say 5×15½=77½ grams) to buy 5 grams of gold, or 155 ms of silver to buy 10 grams of gold. As 31 is the smallest even number this relation, 31 is the smallest number of francs which can be repre- ted by a piece of gold having an even weight of grams. No enlight- d government would consent to confine its gold coinage to pieces of francs and its multiples. We therefore perceive that France has made plete abstraction of metrical weight in its gold coins, not one of ich weighs an even number of grams.

'The gold piece of	5	francs weighs	....	1.6125	grams.
" "	10	"	....	3.3250	"
" "	20	"	....	6.4500	"
" "	50	"	....	16.1250	"
" "	100	"	....	32.2500	"

'The proposed 25-franc piece would weigh 8 grams .0625, and, in fact, ld more nearly approach an even metrical weight than any French d piece now existing.

'This relation of 15½ to 1 is practically prescribed by the French law, ich enacts that 155 (5×31) pieces of 20 francs, being 3,100 francs, ll weigh 1,000 grams, or one kilogram; but the same ratio would exist ween 124 (4 × 31) gold pieces of 25 francs, which would also contain 0 francs, and would also weigh one kilogram.

'The United States have never attempted to fix a decimal weight for ir gold coins, although they were among the first to adopt a decimal netary system. The present gold dollar weighs 25.8 grains troy, which bout equal to 1671 milligrams, and exceeds the metrical weight of French 5-franc piece about 58½ milligrams

A gram of gold nine-tenths fine is equivalent in round numbers to pence English, or 60 cents of the United States. Consequently, 58½ ligrams taken from the dollar would reduce it about 3½ cents, or 292½ ligrams taken from the half eagle of five dollars would reduce it 17½ ts, being about 3½ per cent.

It is needless to expatiate on the comparative merits of a decimal, a decimal, or a binary system, for the reason that the decimal system become a fixed fact in a large portion of the civilized world, render- any change practically impossible. In like manner the unification of coinage of the world has become a question of a nature more practi- than scientific in character, chiefly falling within the domain of com- ce and finance.

To prevent any misapprehension on either side of the Atlantic, it ld be distinctly understood that the conference did not propose, nor any proposition or suggestion made in that body, or elsewhere, to

abandon the use in any way of the word 'dollar,' or 'sovereign,' or 'thaler,' or 'florin,' or 'ruble,' for any other local denomination of money, or in any way to substitute the word 'franc' for any or either of them. By the proposed unification, all those terms will be practically rendered synonymous or mutually convertible, but every nation will continue to e the names with the local emblems it may prefer.

"That such will be the case is now fully evident from the fact that since the adjournment of the conference in July last a preliminary treaty has been signed by accredited representatives from France and Austria, providing for the issue of a gold coin of the weight and value of 25 francs, for the international use and convenience of those two important powers, and by which the 10 florins of Austria are made precisely equal in weight and value to the 25 francs of France, the coin of each nation to be stamped with the head of its respective emperor.

"A specimen or medal in gold, showing the weight and diameter of the proposed coin, with its reverse inscribed '*Or. Essai Monétaire*,' encircling '25 francs, 10 florins, 1867,' has been already struck by order of the government of France, a duplicate of which was recently delivered at Paris to the Emperor of Austria."

A similar specimen or medal in gold has also been struck, inscribed on its reverse "5 dollars, 25 francs, 1867," three duplicates of which, with the proper official letters from M. Dumas, "senator of France and President of the Commission on coins and medals," were intrusted to Mr. Ruggles for delivery to the President, to the Secretary of State, and to the Secretary of the Treasury of the United States. A fourth specimen was presented to the distinguished delegate.

The diameter of this proposed international coin is 24 millimetres, exceeding a little that of the present half-eagle of the United States, and that of the sovereign of Great Britain, while the medallion of the Emperor, in bold relief, on the face of the coin to be issued in France, distinguishes it at once from the ordinary "Napoleon" of 20 francs, which is only 21 millimetres in diameter.

PROFESSOR LEVI'S SPEECH ON THE PROPOSITION OF TAKING THE FIVE-FRANC AS A BASIS OF INTERNATIONAL COINAGE.[1]

With great deference to the proposal of the committee, and much as I agree in the principle therein embodied, I must be allowed to express that it seems to me quite inexpedient and impracticable to take the piece of five francs in gold as the unit of the monetary system for all countries, because it is too small as a gold coin, very easily lost, too costly to pro-

---

[1] This speech, and the following report by the delegates from Great Britain, of the doings of the international monetary conference, are extracted from the official "Report of the International Conference on Weights, Measures and Coins, held in Paris, June, 1867," and "Report on the International Monetary Conference, &c., presented to the House of Commons by command of Her Majesty," in pursuance of their address, dated March 9, 1868. London: printed by Harrison & Sons. Page 75.

duce, much more subject to wear and tear and diminution in value, and too small for large transactions of commerce and finance. In England the introduction of this piece as a unit would be impossible. But it may be taken as a sub-multiple.

It has been suggested that the five-franc piece in gold is very nearly the fifth of the pound sterling, and that it might be made identical. But the value of the pound is 25.20 and not 25 francs. To reduce the value of the pound to 25 francs, we should have to reduce its weight of gold from 7.322 grams to 7.258 grams; whilst, according to the proposition which we have just passed, to make the gold coinage nine-tenths fine, the pound would become heavier in weight by .0166. We have now some 80,000,000 to 100,000,000 sovereigns in circulation. From 1856 to 1866 only, there were issued 49,200,000 sovereigns. If a new pound were coined of 25 francs exactly, the same would have to circulate together with the old pound of 25.20, but the difference between the two would be so slight that we should constantly mistake the one for the other. It was said that government might declare the value of the pound now in circulation at 25 francs, because in effect it is somewhat lighter in weight, and if necessary a seigniorage might be charged. But allowing all this, such difference would not reach 20 centimes on each pound; and if the government should declare the pound 25 francs, which is worth more, the bullion merchants would soon buy it for exportation. And how would old debts and old transactions be affected by such a change? Two pence per pound would have to be given in each case where contracts are pending on the old coinage; and the labor of altering all the books and accounts for that difference would be still more inconvenient, as it is small and in a manner indefinite.

If, therefore, I cannot see my way to approve of the suggestion of reducing the pound to 25 francs, it would be useless for England, and from an international point of view, that France should coin a piece of that sum, which otherwise would not be required in France. Nor does it seem that the maintenance of the pound is likely to lead to the decimalization of the British coinage. The only scheme proposed for that based on the pound sterling is, that which contemplates the division of the pound into 1,000 mills instead of 960 farthings, but serious obstacles attend the carrying out of the scheme. The first is the necessity of altering seriously all the copper coinage, including the penny, which is an old unit in the kingdom, and some of the silver coins also. Change the penny, and what shall be its equivalent for penny postage, penny toll, and all the taxes and all the wages regulated by that coin? Four mills would be too little; five mills too much. Any change in the name of the copper coinage is necessarily attended with great difficulty. A still greater defect of the pound and mill scheme is that many of the coins which this new system would introduce have no distinct equivalent in the coins already in existence. They would stand alone and unchangeable, except with a sacrifice of fractions in every transaction. Another

defect is the undeniable fact that with three decimals, counting always by thousands, no great facility of calculation, no great economy of time, no great conciseness of expression, would in fact be attained. The number of figures required in the present system to express all the sums from one penny to 10 shillings is 250; in the pound and mill scheme it is 335. It would be easier, moreover, especially as it is more familiar to us in England, to conceive the idea embraced in 17 shillings 11 pence than in 895 mills.

Possibly the liability to errors also is even less in the present system than in the other. The only recommendation of that scheme is the maintenance of the pound. But though bankers and merchants confine their attention to that unit, dealing as they do with large transactions, the government could not overlook the penny, and could not ignore the interests of the millions whose daily transactions might be seriously deranged by such a change. A better mode of arriving at a decimal and international system of coinage, it seems to me, is that England should take the 10-franc piece as a unit, and divide it into 100 pence of the current coin; especially since, in reality, the penny is intrinsically, if not nominally, equal in value to the 10-centime piece.[1] What would be the difficulty of her issuing such a coin, which, as suggested, might be called a ducat, and a tenpenny piece as the tenth part of it? Being altogether a new coin it will be easy to issue it of the new alloy, and nearly all the existing coins would continue untouched. It would certainly be better that the shilling and the half sovereign should be withdrawn, because they would be too like the 10 pence and the 100 pence; but otherwise no change would be caused in any of the coins in use. Should the 10-franc piece be found too small as a unit, we may easily have a larger unit in a piece of 100 francs, or of the value of nearly four pounds sterling. For France the unit of 10 francs in gold would be very convenient, as it would perfect her decimal system, and would improve her money of accounts by taking a unit ten times larger than the franc. The United States would have to double their dollar, but the value of everything is now greater than it was some time ago. We find in England that the halfpenny and the farthing are but little used, since we have to pay a penny now for what we paid a halfpenny before, and the experience of the United States will be the same. What we should aim at is, the adoption of one and the same unit by all nations; a unit with subsidiary coins alike everywhere. We must remember that all questions of prices, wages, fares, &c., are generally by such subsidiary coins as the franc, the pence, &c. Unless we attain uniformity in these we effect no real reform. Now, by adopting the 10 francs we have all

[1] If issued in the first instance as a subsidiary coin or token, the gold ducat might be declared by law to be of the value of 100 pence, notwithstanding the slight difference in relation to their nominal value. Should, however, the coin and the decimal system founded upon it find favor with the public so as to justify the government in declaring it a primary unit, then its relation to the sovereign would be regulated by tariff according to its intrinsic value.

this absolutely, and therefore I commend it to the earnest attention of the conference. I have much pleasure in announcing that the Chambers of Commerce, the International Decimal Association, and the Metric Committee of the British Association, have all decided that great advantage would result by the adhesion of Great Britain to the principles of the monetary convention concluded December 23, 1865, between France, Italy, Switzerland, and Belgium, by article 12, of which convention the right of accession is, under certain conditions, reserved for other states. I apprehend that the British government could not authorize her representatives at the Monetary Conference held at the Ministry of Foreign Affairs to make any engagement on this question, because it has not yet been discussed by the nation; but I do not doubt that the resolutions of this and the other conference will have a great influence on public opinion in England, and that, animated by the most sincere friendship for France and for the great sovereign who so wisely presides over her destinies, and most desirous to be united by material, moral, and intellectual bonds with all nations, England will applaud and accept with pleasure the propositions which we may adopt with a view to introducing uniformity in the coinage of all countries.

REPORT BY THE DELEGATES FROM GREAT BRITAIN.[1]

May it please your lordships, we have the honor to lay before you the minutes of the proceedings of the recent International Monetary Conference which we were instructed to attend on behalf of her Majesty's government.

The invitation to the conference emanated, as your lordships are aware, from the French government, and its object was stated to be the discussion of the means by which a complete or partial uniformity might be established between the various monetary systems at present in existence in the countries of Europe and in the United States of America.

The convention of December 23, 1865, concluded between the governments of France, Belgium, Italy and Switzerland, which established an identity in the weight and fineness of the coins of those countries, as well as in the conditions under which they might be manufactured and pass current, was especially indicated as a basis for the deliberations of the conference; the right of joining the convention having by the 13th clause been reserved to all other countries which might be prepared to adopt its provisions.

The necessity for an understanding between the governments of those four states originated in the alteration of the relative value of the precious metals occasioned in recent years by the influx of gold from the newly discovered fields of California and Australia, and the disturbing

[1] Report, addressed to the Lords Commissioners of the Treasury, by the Master of the Mint and Mr. C. R. Wilson, on the International Monetary Conference, December 2, 1867, signed by Sir Thomas Graham and C. Rivers Wilson.

effect thereby created upon the currencies of those countries which had adopted a double standard.

The law under which the system of the double standard operates in France assumes the hypothesis of an arbitrary relation of value between silver and gold in the proportion of 15½ to 1; and, although no doubt this proportion was exact at the period when the law was passed (1803,) it has been considerably modified by the cause above mentioned, which, during the last fifteen years, has thrown upon the market of the world gold to the extent of £340,000,000 in excess of the provision requisite for sustaining the proportion contemplated by the French law.

In France, and in Belgium, Italy, and Switzerland, where the French system has been adopted, and where, consequently, each of the precious metals is a legal tender, it naturally followed that gold gradually displaced silver as an instrument of exchange, and that the latter almost entirely disappeared from circulation.

The inconvenience occasioned by this state of things was principally felt in the scarcity which it created in the smaller denominations of currency, for which gold is inapplicable, and which are indispensable in the ordinary transactions of life, and some attempts at a remedy were made in Switzerland and Italy, and subsequently in France, by increasing the proportion of alloy in some of the smaller silver pieces, thereby reducing them to the position of subsidiary or token coins. The legislation in the three countries was, however, not unanimous, and differed in some essential particulars, while in Belgium no alteration of any kind was attempted.

Under these circumstances overtures were addressed by the government of the country last mentioned to the French government, suggesting a joint examination by France, Belgium, Italy, and Switzerland, of the difficulties which had arisen, and of the remedies to be applied.

The proposal was accepted, and has resulted in the convention of December 23, 1865.

The convention maintains the double standard, fixing the proportion of pure metal in the case of the gold coins of 20, 10, and 5 francs, and of the silver coin of 5 francs at nine-tenths with one-tenth of alloy, as heretofore, but reducing the proportion of fineness in the silver coins below 5 francs from .900 to .835, these subsidiary coins being only made a legal tender to an amount not exceeding 50 francs, (the same limit as that fixed in the case of the English silver token coinage.)

Uniformity of coinage is established by the convention among the countries that are parties to it, but the obligation of accepting reciprocally the coins struck by the different governments is confined to the public treasuries.

Although the causes which led to this convention were of a special nature, nor are we aware that the promoters of it contemplated any ulterior extension of its principles, the union of so considerable a section of the population of Europe seems at once to have given rise to the expec-

tation that it might be made the means of ultimately realizing the idea, which has been a subject of speculation at various times, of a universal monetary confederation.

That project has now been officially adopted by the French government, and it was for the consideration of it in common that the recent conference was convoked.

Before coming to a decision upon the advisability of accepting the invitation, your lordships had carefully to consider the grounds upon which the participation of her Majesty's government in the proposed inquiry could be justified, and the position which should be assumed by their representatives in the event of their deciding that the proposal should be accepted.

Upon the one hand, the inconvenience experienced by some of the countries of the continent owing to the abstraction of silver from circulation, to which we have alluded, has not been felt in England, whose currency is based upon a gold standard, and where, ever since 1816, silver has occupied a subordinate position, the coins of that metal being of the nature of tokens, and only legal tender to the extent of 40 shillings.

Moreover, the currency adopted by the convention of December, 1865, and avowedly recommended as the model for imitation, being based upon the decimal system, offered so wide a divergence from that in operation in this country, which, whatever differences of opinion may exist as to its theoretical perfection, adapts itself well to the requirements of the nation, that a transition from one system to the other, with its many attendant difficulties and disadvantages, or even any sensible modification of our system in the direction of that contained in the provisions of the convention of December, 1865, could only be contemplated on the strongest grounds of expediency.

Upon the other hand, the advantages to be derived from international uniformity of currency, admitting such a consummation to be feasible, were too obvious to be overlooked, and of too vast an interest not to warrant many sacrifices for their attainment; and it was well known that the subject had already attracted a considerable share of public interest in this country, while the interest evinced in the project by the French government, and the anxiety expressed by them for the co-operation of this country, would naturally carry due weight in influencing the determination of her Majesty's government.

Upon a review of these considerations your lordships decided that it would be proper that her Majesty's government should be represented at the conference, but that their delegates should be instructed to abstain from any act or opinion that might appear to pledge her Majesty's government to the adoption of any particular course of action, and that their mission should be confined to a general consideration of the questions that might be brought forward.

The conference was attended by representatives from twenty different

states,[1] and with the exception of the Austrian commissioner, Baron Von Hock, who immediately after the termination of the conference negotiated on the part of his government, and signed a preliminary treaty of adhesion to the convention of December, 1865, none of our colleagues appeared to have received more ample authority than that which we possessed.

Under these circumstances we felt little hesitation, notwithstanding the reserve imposed upon us by your lordships, in recording our votes upon most of the resolutions submitted to the consideration of the assembly.

We proceed at once to state the several propositions which, with more or less agreement, but in all cases after minute discussion, were affirmed by the conference, and which your lordships will doubtless consider worthy of attention, as embodying the authoritative opinion of the representatives of so many countries, and such various systems of currency, as to the most desirable form of monetary union, and as to the most practical means of accomplishing it.

1. The first question which engaged the attention of the conference was whether it were desirable to seek among existing systems one which could be adopted, in its integrity or with modifications, for the proposed international coinage, or whether an entirely new system should be devised.

Whatever the theoretical advantages or perfections which the latter plan might appear to afford—by allowing, for instance, of the creation of a system based upon a gold decimal unit—it was obvious that the acceptance of such a suggestion was inadmissible in practice, owing to the fundamental changes that it would necessitate. The conference, therefore, had no difficulty in affirming the proposition that "monetary unification may be most readily attained by the adjustment of existing systems, taking into consideration the scientific advantages of certain types and the number of the populations by which they have already been adopted," nor in indicating the system of the convention of December, 1865, as that which might be examined with the greatest advantage. It was understood, however, that this resolution involved no opinion upon the subject of the standard, which was reserved for subsequent and separate discussion, and that it was only intended to imply, with regard to the convention itself, that its relative completeness, its subordination to the metrical system, and the large number of the population (72,000,000) that had already adopted it, recommended it generally as a nucleus for the further development of the principles of an international coinage.

It should be mentioned that in the early part of the present year the Papal government joined the convention of 1865, and that in the month

[1] Austria, Baden, Bavaria, Belgium, Denmark, United States, France, Great Britain, Greece, Italy, Netherlands, Portugal, Prussia, Russia, Spain, Sweden and Norway, Switzerland, Turkey, Wurtemberg.

of April last a law was passed in Greece by which the currency of that country has been remodelled upon the provisions of the convention.

2. An inquiry for the purpose of determining the proper standard to be adopted in any general system of coinage might have been expected to elicit much diversity of opinion in an assembly where the three systems of a gold standard, a silver standard, and a double standard were represented, and the unanimous declaration of the conference in favor of a single and a gold standard may be considered as one of the most important features in the deliberations of the conference.

The importance of the decision will be better appreciated when it is borne in mind that only two of the states represented—viz., Great Britain and Portugal—possess exclusively a gold standard, and that the question of the relative advantages of a single or double standard—which in France has been much contested—was, as lately as May last, examined in that country by a government commission, composed of eminent economists, who pronounced by a majority of voices in favor of maintaining the double standard. We annex a copy of their report.

The difficulties to which the adoption of a gold standard would be likely to give rise in the countries possessing a silver standard during the period of transition, formed naturally the next subject for consideration, and the conference expressed the opinion that the silver standard might be maintained as a transitory arrangement until such time as gold should become the principal instrument of circulation.

3. With the view of facilitating and accelerating the transition from a silver to a gold currency, it was thought advisable to add a recommendation that care should be taken to fix the relative value of the two metals at such a proportion as would permit the free introduction and maintenance of gold.[1]

4. It was resolved that a common unit should be adopted for the gold coinage possessing identity of fineness.

The standard of fineness was recommended to be 0.900, *i. e.*, 9 parts fine to 1 alloy, and, although differing from the proportion in use in our mint, which allows eleven-twelfths fine and one-twelfth alloy, we saw no reason to prevent us from joining in the recommendation of the other commissioners, considering that the proportion of nine-tenths is not only that which was adopted by the convention of December, 1865, but is the almost universal rule in the mints of Europe and in the United States, and has even been recently introduced in the coinage of silver dollars at the Hong Kong branch of her Majesty's mint.

The chief recommendation of the proportion of eleven-twelfths consists in the superior hardness of the alloy; but the advantage which it affords in that respect over the coins of nine-tenths fineness is of no considerable importance. At the same time, to guard against any misapprehension, we thought it right to qualify our vote by the explanation that the adop-

[1] The English ratio at present is 14.28; the United States ratio is $14\frac{7}{8}$ for subsidiary silver; the French ratio is $14\frac{3}{8}$ for subsidiary silver.—W. P. B.

tion of the standard of nine-tenths could only be introduced in England in the event of a recoinage.

5. The renunciation of the principle of a currency based on a standard of silver seemed to imply and necessitate the adoption of a common unit of higher value than at present prevailing in countries not possessing a gold standard, and the piece of 5 francs was that which, in spite of individual objections, found favor with the majority of the commissioners.

Exception was taken to it by some of the members for the practical reason of its insignificant dimensions, and upon the more theoretical ground that it does not perfectly harmonize with the decimal system.

We shared this opinion, and were prepared to have suggested as preferable a 10-franc piece, which would not only be free from these drawbacks, but would be more likely to be acceptable in England, which is accustomed to the higher unit of the sovereign.

A new British coin having the same quantity of gold as the 10-franc piece, with the same proportion of alloy, would be within ¾d. of 8s. in value. Such a piece could be legally introduced into circulation as an additional member of the present coinage, provided it was issued as a token coin for 8s., and made a legal tender to a limited amount only, such as £4, or 10-franc pieces. It could have inscribed upon it "10 francs," in addition to its current value of "8 shillings."[1] This coin would become the unit of computation, the new pound, or metrical pound, or it might be made the tenth part of a new metrical pound, if a denomination of higher value were demanded. We would thus become possessed of an international coin.

The scheme of coinage which it would be the means of suggesting is one resting upon the penny reduced four per cent. in value, and would include a silver piece of 10 such pence, in addition to the gold piece of 100 pence. The ultimate adjustment of the European and American coinages contemplated would present:

In the French coinage—

1 franc divided into 100 centimes.

In the American—

5 francs ($1) divided into 100 cents.

In the British—

10 francs (gold florin, one metrical pound, or one-tenth of a metrical pound) divided into 100 pence; with the addition, if desired, of 100 francs (one metrical pound, £4 sterling) divided into 1,000 pence.

Such a coin as the gold 8s. piece could be produced without expense, owing to the seigniorage of ¾d. which it would yield as a token, and the piece could be made sufficiently distinctive by giving it a plain edge. For the issue of such a piece there is the precedent of the silver florin, which was devised to represent the pound and mill system, and to bring that system under the notice of the public. The 8s. piece proposed would represent the metrical system founded upon the penny, which has always

[1] It would be better to stamp such a coin 100 pence rather than 8s.—W. P. B.

en a rival with the former in general estimation, and which seems titled to equal consideration at the hands of government. The issue such a piece, while it brought the metrical system of coinage into tice, would not be conclusive as to the ultimate adoption of that stem, but would leave it possible to advance in such a course, or to cede from it at any time without embarrassment.

We may mention that M. de Jacobi, the representative of Russia, threw it the suggestion that the objections to the 5-franc piece on account of s small size might be obviated by the introduction of platinum as the etal of which it should be composed, observing that a supply in suffi ent quantities could be obtained from the Russian and South American ines, and that the disadvantages formerly presented by the difficulties working it had been, in a great measure, removed by recent improve-ents.

By a subsequent vote, in which we did not feel called upon to join, an inovation was recommended in the principle of the convention of 1865, hich limited the reciprocal obligation of accepting the coins of the Inion to the public treasuries, by a proposal that the common coin of francs should be made a legal tender throughout the countries which night unite in a monetary convention.

6. The next proposition, viz: whether the proposed system should nclude a coin equivalent to 25 francs, offered considerations of more pecial interest to the English delegates, inasmuch as it indicates what, at present at all events, is believed by many persons to be the only prob-able method by which an alliance may be effected between the English monetary system and that adopted under the convention of December, 1865, by so large a portion of the continent of Europe, and which will, no doubt, receive a still wider extension.

Indeed, as we had occasion to point out, the 25-franc piece is by no means a necessary ingredient or consequence of the scheme recommended by the conference, and was avowedly proposed and supported chiefly in the hope of securing the adhesion of Great Britain, to which, on account of her large monetary circulation, the activity and extent of her com-mercial transactions, and the influence which they exercise in every for-eign country, a natural importance was attached.

At various stages of the discussions the question of equalizing the pound sterling with 25 francs of French gold was brought forward by different members of the conference, with no undue depreciation of the difficulties which must be encountered in carrying the alteration into effect, but with a generally expressed conviction that these difficulties were in no way insurmountable.

The English sovereign contains 123.274 grains troy, including one-twelfth of alloy; that is to say, 113.002 of fine gold, equivalent to a weight in French grams of 7.322.

A gold piece of 25 francs would contain 7.258 grams of pure gold, besides one-tenth of alloy, representing a difference in favor of the Eng-

lish coin of 0.064, or 64 milligrams, and an excess of pure gold in the English over the French coin of .825 per cent., equal to, as nearly as possible, 20 centimes, or, speaking roundly, 2*d.*

The process of assimilation would, therefore, consist in diminishing the value of the pound sterling by 2*d.*, and substituting for the present sovereign a coin (reduced in fineness to .900) which would exactly correspond in value with the proposed French gold piece.

The mode by which the process might be effected was freely debated, and opinions were expressed that the existing sovereigns might be maintained in circulation by taking advantage of the loss of weight by wear allowed by law, and which permits a divergence of .774 grains, or .628 per cent. (1½*d.* nearly) from the exact weight; but we felt it our duty to declare our opinion that such an expedient would be considered inadmissible in England, and that we were satisfied that so essential a change could only be carried out at the cost of a recoinage of our whole gold currency, variously estimated at from £80,000,000 to £120,000,000.

It was allowed that the sovereign might continue to be divided as at present, into 20 shillings; but it is obvious that, unless the sovereign were divided into 25 francs, small progress would be made towards a general unification of coinage. Now the division of our pound into 25 would be found inconvenient in circulation, and would soon lead, in all probability, to the issue of a 20-franc piece to supersede the former.

We do not feel called upon in the present report to enter into any discussion upon this question, which would doubtless form the subject of serious consideration hereafter, should her Majesty's government determine to institute an inquiry into the possibility of associating this country in the system of international coinage recommended by the Paris conference.

We confine ourselves to reporting the earnestness with which the proposition above mentioned was pressed upon our attention, and with which the hope was expressed that it would be made the subject of mature consideration by her Majesty's government.

Our attention was directed to a small variation in the weight of the sovereign proposed upon other grounds. It is well known that all gold brought to the mint is returned in the form of sovereigns without deduction or charge; and there is no doubt that our practice is correct in principle for the metal which, like gold, is adopted as the measure of value. But it is at the same time undeniable that some additional value is imparted to the metal by the work applied to it in coining, and a small charge to cover, or partially cover, the mint expenses is on that account generally imposed upon coin in the countries of the continent, under the name of *brassage*. In France the charge thus borne by the holders of bullion amounts to 6 francs 70 centimes on a kilogram of gold, which is coined into 155 Napoleons, or 3100 francs, being equivalent to 4.32 centimes on a 20-franc piece. The system of free mintage has also, since 1853, been abandoned in the United States, where, in addition to the

charge for refining, a charge of one-half per cent. (50 cents on $100) is now taken upon all gold brought for conversion into coin. A small mint charge does not appear to be complained of anywhere. The charge acts usefully for the preservation of the coin, by removing any inducement to melt it down for any ordinary technical purpose, or even to supply bullion to foreign mints. We have reason to fear, from what we learned from professional members of the monetary conference, that the British gold coinage is liable to suffer heavily in this way. London is the entrepôt for the precious metals from which other countries draw their supplies. Now, gold may be procured from London either in the form of bars or sovereigns, at the same price; while to the foreign purchaser, if a mint contractor, sovereigns offer the following advantages: The assay may be safely relied upon, the gold is already alloyed with copper, and, more than all, the suitability of the metal for coining is insured. Further, sovereigns are taken by number, and the aggregate weight may be as nearly as possible correct. But that is not true of the weight of individual pieces, which, from the unavoidable imperfection of manufacture, are some heavy and some light within a certain small range, recognized as the tolerance in coining. There is reason to believe that large masses of new British sovereigns are occasionally treated so as to separate out the heavy pieces, and these are disposed of as bullion; while the lighter pieces, which may still be all of legal weight, are preserved and put into circulation. This fact will not surprise those persons who are aware of the small margin of profit upon which bullion transactions are often conducted.

A small mint charge on the British sovereign thus appears to be called for, as the necessary means of the preservation of the coin, while the measure is further recommended as an equitable re-payment to the country of the cost of coinage.

Although this question of the introduction of a mint charge into our system of coinage was only incidentally considered by the conference, we have thought it desirable to mention it somewhat prominently, in consequence of the notice which it has occasionally attracted in this country, and the importance which it would doubtless assume as an element of discussion in the consideration of any scheme involving a re-coinage of the gold currency.

We must state that the adoption of the 25-franc piece was warmly supported by Mr. Ruggles, the representative of the United States, who informed the conference that his government attached much importance to the coinage by France of pieces of that denomination.

Mr. Ruggles made the important statement that the United States were prepared to re-coin the whole of their gold, with a view of remodelling their system upon the basis of the convention of December, 1865; and that notwithstanding the serious loss which such a proceeding would entail, involving a diminution of no less than three per cent. in the value of their gold circulation, a far greater proportion than that involved in

the proposed conversion of the English sovereign, they looked to no reciprocal advantage beyond the coinage of a 25-franc piece, which would exactly correspond with the half eagle.

7. Considerable difference of opinion was expressed upon the proposal that a piece of 15 francs should be included in the recommendations of the conference. The object of the suggestion was to secure the creation of a coin nearly identical in value with 7 florins of Holland or South Germany, and 4 thalers of Prussia, as an inducement to those countries to adopt a coin representing denominations of their own currency, but which would be interchangeable with a French 15-franc piece.

In common with several of our colleagues we abstained from voting upon this question, respecting which no final decision was taken.

8. Having thus enunciated principles for the construction of an international monetary system, the conference added an expression of their opinion that it would be convenient, and in accordance with the idea of union sought to be established, that the governments of such states as might decide an introducing modifications in their system of coinage based upon on adoption of those principles should, as far as possible, make any measures to be taken for that purpose the subject of diplomatic conventions.

9. At the final meeting of the commissioners, his Imperial Highness Prince Napoleon, the president of the congress, expressed to them the anxiety of the French government for a practical and early realization of the scheme embodied in the recommendations of the conference, and encouraged them with considerable earnestness to communicate to their respective governments the hope which the imperial government entertained that in those countries whose circumstances might render their immediate or complete adhesion to the proposed system impossible, some inquiry might, at all events, be forthwith instituted for the examination of its merits and of its adaptability to their own systems and their own peculiar requirements.

His Imperial Highness accordingly proposed that an early date should be fixed by which the several governments should be invited to come to some decision as to the course which they might consider it advisable to adopt, and that their views should be then communicated to the French government, who would examine, upon a review of the several opinions expressed, whether a further combined consideration of the question would be desirable.

We expressed our disinclination to indicate any fixed period within which it could be expected that the English government would be able to announce a final decision upon so difficult and momentous a question, but stated that in the event of the feeling of the conference being in favor of accepting the suggestion of the president, we could only desire that a sufficiently long delay should be named to admit of Parliament having an opportunity, should it think proper to do so, of discussing and pronouncing an opinion upon the subject. With this view we suggested

the 1st of June, 1868, as a date by which her Majesty's government might possibly be in a position to make some official communication of their views and intentions.

The anxiety, however, expressed by Prince Napoleon for an earlier consideration of the matter, was shared by the majority of the conference, who fixed the 15th of February, 1868, as the date by which the governments should be invited to make known their intentions to the government of the Emperor.

It will be for her Majesty's government now to determine whether any special inquiry should be established into the results of the deliberations of the conference, and, if so, what form the inquiry should assume.

Your lordships will, no doubt, consider that such an investigation is properly due to the intrinsic importance of the question, as well as to a consideration of deference to the earnest interest with which its development from theory to practice has been advocated by the French government, under whose auspices the conference was assembled, and which has expressed so cordial a desire for the further co-operation of this country.

The appointment of a royal commission was made February 18, 1868, by the Queen. The commission had power to call before it, or any five members, such persons as are regarded as "better informed of the truth in the premises," and was required to report in writing, as soon as reasonably could be, the proceedings and opinions.

This commission reported on the 25th of July, 1868,[1] adversely to the reduction of the value of the pound to that of 25 francs, and also to the adoption of a gold coin of the value of 25 francs, to be substituted for the sovereign. The report says: "The reduction of the value of the pound would disturb all existing obligations and would cause many and serious difficulties;" and further, that "the measure is, after all, only a partial measure; and although advocated by some witnesses as good in itself, and as a step to further assimilation, the objects sought for by the witnesses connected with the trade and with the scientific bodies of this country would not be fully attained by anything less than a complete assimilation of the currencies of different countries."

"Several witnesses who took this view deprecated any change unless a complete assimilation of currency of moneys of account as well as of coins was made."

VIEWS OF M. CHEVALIER.

At the conclusion of the reading of the report by Baron de Hock at the third sitting, June 27, 1867, M. Michel Chevalier offered some observations on propositions four and five. He expressed the opinion "that the monetary unit should only be a branch of the general weights and measures, which is the metric system, the essence of which was to

[1] *Vide* Blue Book—Report from the Royal Commission on International Coinage, together with the minutes of Evidence and Appendix.

have the whole subordinate to the metre. The coinage ought not to stand on an independent basis," and, notwithstanding the accidental and happy circumstance that the most important monetary unit may be adapted to the piece of five francs in gold by means of very small changes, he considered that it would be best to change radically all the monetary system, and to adopt everywhere as a unit a weight of gold of 5 or 10 grams at .910 fine. The speaker was convinced that the English, faithful guardians at all times of the fineness of their coins, would refuse to lower the pound sterling to 25 francs.

M. ZEER HERZOG was in favor of accepting the piece of 5 or 10 grams if he had any hope that it would become the universal coin; but experience has shown that monetary units are not artificially created. The franc owes its easy adoption to its similitude to the ancient *livre tournois*, and the attempt made in Germany, in 1857, to create a common gold coin of a metric weight has proved a complete failure.

M. MICHEL CHEVALIER said that it was doing injustice to human intelligence to think that it was incapable to abandon old habits, but in reality we would return to the old practice by giving back to money its true significance, an exact weight, as the words *pound* and *marc* prove.

The views of M. Chevalier were further expressed in a letter to the Journal des Debats in which he discussed the monetary question then before the International Conference. That discussion was cited as follows by the Paris correspondent of the London Economist:

"He admits that, though there is much to be said in favor of the French one franc piece in silver, there is no chance of a silver standard being adopted, 'gold having,' he says, 'obtained the preference of the greatest number of States. The English,' he continues, 'are very determined on this point; they will have gold pieces, nothing but gold. Silver, with them, is only employed to make up sums, and silver pieces are of a nominal value superior to their real one. The Americans appear to be not less determined in favor of gold pieces; and Portugal has the same sentiment.'

"Having said this, he shows briefly the objections, scientific and practical, to maintaining both silver and gold standards, inasmuch as it is impossible to keep up a fixed proportion in the value of the two metals. Then he examined the proposition which has been made to reduce slightly the value of the English sovereign (by about 2*d.*) and the United States five-dollar gold piece, in order to make them equal to 25 francs French, and to coin 25-franc gold pieces in France. But he doubts that the English would consent to such a measure. 'They are rigorous,' says he, 'on the chapter of money. They shrink from no sacrifice to maintain their money perfectly intact; they make it a point of honor so to do, and they are right.' Besides, he doubts that the French gold coin, which is now of 20 francs, with subdivisions of 10 francs and 5 francs, 'possesses a character which imposes it on the adoption of other nations.'

"And these are his reasons: 'The metrical system is now in favor verywhere. But unfortunately the French gold piece is out of the pale f the metrical system. In respect to this system, a piece like that of 0 francs, which weighs 6.451 grams and an indefinite fraction, is as bsurd as the pound sterling, the gold dollar, the eagle, or half-eagle, he doubloon, the German crown, and any other gold piece which circu- ates. The English are as much justified in recommending for universal nity the pound sterling, or the Americans the dollar, or the Spaniards he doubloon, as the French are in recommending the 5-franc piece, r the 20-franc piece, or the 25-franc piece in gold.' The great economist herefore advises that *from respect for the metrical system, the French hould abandon their gold pieces.*

"He observes that by so doing they would prove the reality of their aith in that system, 'faith without works being dead.' Nevertheless, e does not deny that if the International Commission should resolve on lacing the English pound sterling, the United States half-eagle, the mperial of Russia, and an Austrian gold piece of 10 florins, on a level rith a French gold coin of 25 francs, it would be a progress compared rith the existing state of things. 'We, however,' he adds, 'should eel regret at the reform not being made more complete and more rational— at stopping half-way when it was possible to go the whole distance. Modern nations,' he remarks in conclusion, 'like progress so much that they may confidently be called on to make an effort when an important and definitive amelioration has to be effected.'

From the above it appears that leading political economists of France were earnestly averse to the recommendation of the international com- mittee of the Paris Exposition in favor of the substitution of the weight of the French five-franc piece of gold for that of the United States gold dollar. Their opposition was based on the *unmetrical* character of the proposed monetary unit.

OPINIONS EXPRESSED IN THE UNITED STATES.

The views of Mr. Ruggles in respect to the coinage of a 25-franc piece have not found ready acceptance by the scientific men of the United States who have given the subject thoughtful investigation. The great objection to the system of unification proposed by Mr. Ruggles is that t is not metrical—in other words, that the coins of the denominations and values proposed do not have simple relations as to weight with the gram, which is the unit of weight of the French metrical system.

The gold coin of France is not metrical; it has no simple relation to he metric unit of weight. In changing the coinage of the world, met- ical unity is one of the first considerations. If we first obtain metrical armony, unification of coins will follow. The gold coin of the United tates is much more nearly metrical than the gold coin of France. The hree-dollar gold piece of the United States weighs 5.015 grams, and the

other coins are in proportion. By reducing the weight this small fraction, and making the three-dollar coin weigh exactly five grams, a simple metrical relation will be established. The German crown has an exact simple relation; it contains 10 grams of pure gold.

The silver coin of France has simple relations to the gram, and is therefore metric. The ratio of value of silver to gold adopted by France (viz., 15½ to 1) is an undesirable one; it causes silver coin to be underrated, instead of being overvalued, as it should be, it being above the average market rate, (15⅜,) for the past 14 years, or since the discovery and working of the rich gold regions of California and Australia. The ratio of 15 to 1 originally adopted for the coinage of the United States in 1790 is a more satisfactory ratio, being below the market rate during the past 150 years, and being very simple for purposes of computation.

PETITION TO CONGRESS FROM THE AMERICAN STATISTICAL ASSOCIATION.

The petition of the American Statistical Association, adopted at its meeting in Boston in the year 1867, and presented in both houses of Congress, respectfully asks attention to the following propositions, and requests that the principles involved in them may be incorporated in any law that may be adopted in respect to the metrical system of weights, measures, and coins:

First. That the American Statistical Association earnestly favors the speedy practical adoption by the people of the United States of the metrical system of weights and measures; the system of which the metre, the litre, and the gram are respectively the units of length, of capacity, and of weight, and the use of which, by act of the last (the 39th) Congress, has been rendered permissible in the United States in the making of contracts, and has been necessitated by the requirements of several branches of industry.

Second. That our coinage should have simple relations as to weight with the unit of weight of the metrical system, the gram.

Third. That the standard as to fineness of our coinage, whether of gold or silver, should continue as now, nine-tenths of fine metal to one-tenth of alloy.

Fourth. That in the opinion of this association no widely-extended and permanent uniformity as to coinage can be secured through the adoption by our government of any system which is in conflict with the principles above mentioned.

Fifth. That the weight in grams and the fineness of the coins hereafter to be issued should be legibly stamped thereon prior to issue.

Sixth. That the changes required for converting our existing coinage into a metrical one are so slight that the recoinage of the existing coins of the United States would be unnecessary; that the difference between the existing coinage and that proposed, especially as regards gold coins of less denomination than $10, is very considerably less than the devia-

tion now allowed to the mint, which is one-fourth of a grain for the gold dollar and the quarter eagle, and one half of a grain for the half eagle, the eagle, and the double eagle.

Seventh. That, in pursuance of the foregoing, the gold dollar should contain $1\frac{1}{2}$ grams of fine gold, or its equivalent, $1\frac{2}{3}$ grams of standard gold, (nine-tenths fine,) and that other gold coins should be in proportion.[1]

Eighth. That the silver half dollar and the smaller silver coins hereafter to be issued should contain of fine silver at the rate of $22\frac{1}{2}$ grams to the dollar, or their equivalent, 25 grams of standard silver, (nine-tenths fine.)[2]

Ninth. That the gold coinage, as above described, should be made legal-tender in payment of sums of all amount; and that the silver coinage should be subsidiary, and admitted as legal-tender to an amount not exceeding $10 in any one payment.[3]

REPORT OF SENATOR SHERMAN.

In the Senate of the United States, June, 1868, Mr. Sherman made the following report,[4] to accompany Senate bill No. 217:

"The following documents have been referred to the Committee on Finance:

"1st. S. 217, in relation to the coinage of gold and silver.

"2d. S. 412, to promote uniformity of coinage between the moneys of the United States and other countries.

"3d. The proceedings of the International Monetary Conference, held at Paris in June, 1867.

"4th. The report of Samuel B. Ruggles, esq., delegate from the United States in the International Monetary Conference at Paris, November 6, 1867.

"5th. Sundry memorials relative to changes in our system of coinage.

---

[1] The weight of the existing gold dollar, when new, is slightly (only about three-tenths of one per cent.) in excess of the proposed metrical dollar, the former containing of fine gold 1.505 grams, or of standard gold (nine-tenths fine) 1.672 grams; an excess of about 5-1000ths of a gram, or 8-100ths of a grain, and which is about one-third of deviation allowed the mint.

[2] The existing legal-tender silver 5-franc piece of France contains 25 grams of standard silver, (nine-tenths fine,) or $22\frac{1}{2}$ grams of fine silver, the same as herein proposed. Our existing fractional and subsidiary silver coins are somewhat smaller than the above, about one-half of one per cent., containing of standard metal at the rate of 24.86 grams to the dollar, instead of 25 grams, the difference being inconsiderable.

[3] It will be observed that the proposed silver coinage has precisely 15 times the weight of the proposed gold coinage of the same denominations. The market equivalent is, and for the past 60 years has been, greater than this, the value of gold relatively to silver having averaged for the past 14 years $15\frac{4}{9}$ times that of silver. Hence, by the above propositions, silver is overvalued, as, according to the experience of all commercial nations, it should be. But, to prevent the silver from driving the gold from circulation, it is necessary, as proposed, that the silver should be legal-tender only in payment of sums of small amount. The limit in the United States is now five dollars; in England 40 shillings, (about $10.)

[4] Senate report No. 117, 40th Congress, second session.

"These documents present to the Committee on Finance the interesting question of international coinage, and in considering them we necessarily inquired:

"1st. Whether the object proposed was of sufficient importance to justify a change in the coinage of the United States.

"2d. Whether the plan proposed by the Paris conference was the best mode to accomplish the end desired.

"3d. What legislation was necessary on the part of the United States to adapt our coinage to the plan proposed.

"4th. What provision should be made for existing public and private contracts.

"Your committee, after a partial consideration of these questions, direct that the bill first named be reported with amendments, supported by the following report, and that Mr. Morgan, of the same committee, be authorized to submit a report adverse to the bill, and that these reports be printed, and that the bill be postponed until next session, with a view to elicit a fuller discussion by the people of the several questions embraced in the bill.

"The importance of a common monetary standard among commercial nations has always been conceded. It has been the hope of philosophers and statesmen and the demand of writers on political economy for centuries, but has been as strongly opposed by the jealousies of locality and the interests of rival nations. Commerce and peace have steadily approximated different standards of exchange towards each other, while local interests and war have as steadily diverged them from each other. In all ages local and generally despotic authority has endeavored to make more money out of a given amount of gold and silver by clipping or alloy, while the general laws of trade and commerce have soon after reduced the current value of the money as it was reduced in weight and fineness. Formerly, not only each nation, but each province, duke, bishop, or municipality, made its own separate and distinct coin, often of the same name but different values. The effort to unitize the different moneys of a nation was but a part of the process by which the modern nations of Europe have been formed, and in this process the original money was debased in a remarkable way. The pound sterling of England was, at the time of William the Conqueror, equivalent to a pound weight of silver. It is now 3 oz. 12 dwt. 16 grs. The German florin was originally a gold coin, worth about $2 40. It is now a silver coin, worth about 40 cents. The French livre originally contained a pound of silver, worth about $18 50. It is now worth about 19 cents. The Spanish maravedi in the year 1220 was worth $3 20 of our money. It is now worth about a quarter of a cent. The result of these changes has been to secure to all parts of each leading nation a common unit of money—of fixed value. The pound sterling is the unit in Great Britain; the franc in France, Italy, Switzerland, and Belgium; the florin in South Germany; the thaler in North Germany; the dollar in the United States,

and various other units in other nations. These units are purely arbitrary, based upon local law, and diverse in weight, value, and alloy. They are, in some nations, of gold only; in some, of silver only; and in some a compound standard of gold and silver, and differing materially in the amount of alloy, and in the relative value of the two metals.

"For local purposes it is not very material which metal is the standard nor of what weight and fineness the standard may be, if only it is of fixed and invariable value, for the value of property and all internal commerce adapts itself to the intrinsic value of the gold and silver in the prescribed standard.

"The inconvenience of different standards of value arises mainly in foreign commerce, in the exchange of commodities among nations. The intercourse between modern Christian nations is now more intimate and exchange more rapid than it was between provinces of the same country 200 years ago. The annual trade between the United States and Great Britain is now greater in bulk and value than the aggregate annual trade between all the nations of Europe 200 years ago. The same reasons for adopting an international standard of value now exist as nduced the American colonies, less than 100 years ago, to abandon their liversified standards of value, and adopt as a common unit the American dollar. Every advance toward a free exchange of commodities is an advance in civilization. Every obstruction to a free exchange is born of the same narrow despotic spirit which planted castles upon the Rhine to plunder peaceful commerce. Every obstruction to commerce s a tax upon consumption; every facility to a free exchange cheapens commodities, increases trade and production, and promotes civilization. Nothing is worse than sectionalism within a nation, and nothing is better or the peace of nations than unrestricted freedom of intercourse and ommerce with each other. No single measure will tend in this direcion more than the adoption of a fixed international standard of value, by which all products may be measured, and in conformity with which he coin of a country may go with its flag into every sea and buy the products of every nation without being disconcerted by the money hanges.

"This has been the wish of American statesmen since the revolutionary war. The Spanish milled dollar was adopted as the basis of our coinage efore the Constitution was framed, and with the hope, expressed by Mr. Jefferson, that it would lead to an international unit. Mr. Hamilton nd Mr. Gallatin each desired the same result, but the French war postoned all efforts in that direction. Mr. John Q. Adams, in his remarkble report to Congress of February 22, 1821, upon the kindred but more omprehensive subject, 'the uniformity of weights and measures,' says:

"'This system approaches to the ideal perfection of *uniformity* applied o weights and measures, and, whether destined to succeed or doomed o fail, will shed unfading glory upon the age in which it was conceived nd upon the nation by which its execution was attempted and has been n part achieved.

[illegible] earth be an improvable being; if that universal peace, [illegible]bject of a Savior's mission, which is the desire of the [illegible] longing of the philanthropist, the trembling hope of the [illegible]essing to which the futurity of mortal man has a claim or [illegible]rtal promise; if the spirit of evil is, before the final consum[illegible]ings, to be cast down from his dominion over men and bound [illegible]ains of a thousand years, the foretaste here of man's eternal [illegible]hen this system of common instruments to accomplish all the [illegible]ges of social and friendly commerce will furnish the links of sympa[illegible] between the inhabitants of the most distant regions; the metre [illegible] surround the globe in use as well as in multiplied extension, and [illegible] ne [illegible]ge of weights and measures will be spoken from the [illegible] poles.'

[illegible]al efforts have been made by negotiation to secure uniformity of coinage, especially with great Britain.

"In 1857, in compliance with an act of Congress, passed upon the report of the Committee of Finance of the Senate, Professor Alexander was sent as a special commissioner to that country to secure a unity of coinage between the two countries, but, after various conferences, the mission failed from an indisposition of the English government to modify their pound, shilling, and pence.

"In his report of December, 1862, Mr. Secretary Chase invited the attention of Congress to the importance of uniform weights, measures, and coins, and recommended that the half eagle of the United States be made equal to the gold sovereign of Great Britain in weight and fineness.

"The Berlin International Statistical Congress, held in 1863, composed of representatives of 14 countries, and at which the United States was ably represented by Mr. Ruggles, agreed to the following resolution:

"'1st. That the Congress recommends that the existing units of money be reduced to a small number; that each unit should be, as far as possible, decimally subdivided; that the coins in use should all be expressed in weights of the metric system, and should all be of the same degree of fineness, namely, nine-tenths fine and one-tenth alloy.

"'2d. That the different governments be invited to send to a *special congress* delegates, authorized to consider and report what should be the relative weights, in the metrical system, of the gold and silver coins, and to arrange the details by which the monetary system of different countries may be fixed according to the terms of the preceding propositions.'

"This led to the recent Paris conference and to the adoption by Congress, in 1866, of several measures for the use of the metric system of weights and measures. At the Paris conference 19 nations were represented, governing a population of 320,000,000 European and American, and 190,000,000 Asiatic.

"The conference agreed with great unanimity upon the plan hereafter

stated, and the delegates from the United States were active and influential in harmonizing conflicting views and in securing the result arrived at. Upon the first part of their inquiry, your committee therefore conclude that the object proposed is of the highest importance, constantly sought for at every period of the government, and that the United States is fully committed to its support if the plan proposed is practicable and just.

"Aside from the general advantages which we will share with the civilized world in attaining a uniform coinage, there are special reasons why the United States should *now* adopt the system.

"The United States is the great gold-producing country of the world, now producing more than all other nations combined, and with a capacity for future production almost without limit.[1] (See reports of Mr. Ruggles and J. Ross Browne.) Gold with us is like cotton, a raw product. Its production here affects and regulates its value throughout the world Every obstruction to its free use, such as the necessity of its recoinage when passing from nation to nation, diminishes its value, and that loss falls upon the United States, the country of production.

"2. The United States is a new nation, and therefore a debtor nation. By placing ourselves in harmony with the money units of creditor nations, we promote the easy borrowing of money and payment of debts without the loss of recoinage or exchange, always paid by the debtor. This is necessarily so where the debt is payable abroad, and if payable here the creditor discounts the exchange and difference in coinage in advance.

"3. The technical rate of exchange between the United States and Great Britain, growing out of the different nominal values of coin, is a standing reproach which can only be got rid of by unifying the coinage of the two countries, when both the real and technical rate of exchange will be at par with only such slight variations as will indicate the course of trade.

"4. Gold is now demonetized as a currency, and the great bulk of it in the United States is now held in the treasury, so that it is not possible to select a time when this great international change of coinage could affect the interests of our people less. From inquiries made of the officers of the mint we find that the cost of reminting the present coin would be less than one-twentieth of one per centum. The fineness of the proposed coin being the same as the old, there would be no assay, and the cost of the change would not be perceptible to the holder of the coin, and scarcely so to the government.

"The second inquiry of your committee was whether the plan proposed by the Paris conference was the best mode to accomplish the end desired.

"It proposes:

"1. A single standard, exclusively of gold.

"2. Coins of equal weight and diameter.

"3. Of equal quality or fineness—nine-tenths fine.

---

[1] Upon these points the foregoing pages of this report and the tables of production in Chapter viii may be consulted.—W. P. B.

"4. The weight of the present five-franc gold piece to be the unit.

"5. The coins of each nation to bear the names and emblems prepared by each, but to be legal tenders public and private in all.

"1. The single standard of gold is an American idea, yielded reluctantly by France and other countries, where silver is the chief standard of value. The impossible attempt to maintain two standards of value has given rise to nearly all the debasement of coinage of the last two centuries. The relative market value of silver and gold varied like other commodities, and this led first to the demonetization of the more valuable metal, and second to the debasement or diminution of the quantity of that metal in a given coin. In a short time the cheaper metal would by a diminished supply become the dearer metal, and then it would be debased and cheapened in the same way. This process repeatedly occurred in Europe, and has twice occurred in the United States within the life of the present generation. By the act of June 28, 1834, our gold coin was reduced from 270 grains of standard gold to 258 grains, or 4.4 per centum, in order to make it correspond with the market value of silver. In consequence of the discovery of gold in California that metal was cheapened, and silver became relatively more valuable and was hoarded or exported. To avoid this the weight of our silver coin was reduced by the act of January 21, 1853, from 206 grains of standard silver to 192 grains, or 6.7 per centum.

"This subject early excited the attention of financiers. Mr. Gorham, in his report of May 4, 1830, as Secretary of the Treasury, forcibly says:

"'Amidst all the embarrassments which have surrounded this subject since the adoption of metallic standards of property, it is remarkable that governments have so tenaciously persevered in their effort to maintain standards of different materials, whose relation it is so difficult to ascertain at any one time, and is so constantly changing; and more especially when a simple and certain remedy is within the reach of all. This remedy is to be found in the establishment of one standard measure of property, only. The evil of having two or more standards arises, as already observed, from the impossibility of so fixing their relative values by law that one or the other may not, at times, become of more value in market than estimated by regulation; and, when this happens, it will be bought and sold according to its market value, regardless of the law.

"'The proposition that there can be but one standard in fact is self-evident. The option of governments charged with this duty is therefore between having property measured sometimes by gold and sometimes by silver, and selecting that metal which is best adapted to the purpose for the only standard. Why the latter course has not been universally adopted it is not easy to explain, unless it may be attributed to that prevalent delusion which seeks to secure the possession of gold and silver by restraining their exportation, and avoiding the payment of debts rather than improving the public economy by giving every facility to it.'

"The opportunity is now offered to the United States to secure a com

mon international standard in the metal most valuable of all others—best adapted for coinage, mainly the product of our own country, and in conformity with a policy so constantly urged by our statesmen, and now agreed to by the oldest and wealthiest nations of the world. Surely we should not hesitate for trifling considerations to secure so important an object.

"The equal weight and diameter of coins will guard against adulteration and counterfeiting, and will familiarize our people with the metric system of weights and measures. This system is already used in some of our coins, and is permitted by our laws, and will, by gradual means, become adopted as the only international system.

"The provision made that each nation shall retain its own emblems, will not impair the ready currency of coin, but will induce care in coinage. The fineness proposed is the present standard of the United States—an important consideration in recoinage, as no new assay will be required.

"All the provisions of the plan proposed are in harmony with the American system of coinage. They are either already adopted or may be without inconvenience. The only point upon which a diversity of opinion may arise is as to the unit of value, and here the chief difficulty was not as to what particular quantity of gold was the best unit, but upon what quantity all the nations represented could agree. The unit recommended is the existing 5-franc gold piece, 620 of which weigh a kilogram.

"For the reasons that induced the adoption of this unit of value, reference is made by your committee to the report of Mr. Ruggles. They may be summed up as follows:

"1. The coin proposed is the smallest gold coin in use, and therefore the most convenient unit of value.

"2. It approximates more nearly to existing coinage of the great commercial nations than any other proposed. The dollar reduced $3\frac{1}{2}$ cents at the mint becomes the unit of value, and its decimal divisions and multiples enable us to retain all our well-known coins, both of gold and silver.

"A very slight reduction of the English sovereign makes it conform to the multiple of the dollar and franc, so that five francs are a dollar, and five dollars are a sovereign, or a half-eagle. The same unit is easily adapted to existing coinage of other nations.

"3. The franc is already in use by 72,000,000 of the most industrious and thrifty people of Europe—France, Belgium, Italy, Switzerland, and Holland.

"4. The actual gold coinage in francs from 1793 to 1866 was $1,312,220,814, while the gold coinage in dollars during the same period was $845,536,591, and in sovereigns was $935,341,450, thus showing that in France alone the existing gold coinage on the proposed standard is greater than upon any other that could be adopted.

"It must be remembered that the great body of our coin and bullion has been exported, and is now in foreign coin; that a large part of the balance is held in the treasury, and that less gold is in actual circulation in

the United States than in any other great commercial nation. It is unreasonable, in view of these facts, for the United States to demand that our dollar, composed of 1671.50 milligrams of gold, should be the standard of value. As the nation most interested in international coinage, we should be ready to yield something to secure that object. By the plan proposed we yield nothing except the very small reduction of the weight of our standard, and without any other change in our coins, multiples, divisions, devices, or alloy.

"5. France, whose standard is adopted, makes a new coin similar to our half-eagle. She yields to our demand for the sole standard of gold, and during the whole conference evinced the most earnest wish to secure the co-operation of the United States in the great object of unification of coinage. Her metric system is far the best yet devised and is in general harmony with our own, while Great Britain has refused even to negotiate with us for unity of coinage, and maintains the most complex system of weights, measures, and coinage now in use among Christian nations. The decimal system, the basis of all our computations, she rejects, and adheres to the complex division of pounds, shillings, and pence, which we rejected with colonial dependence.

"These reasons induce your committee to earnestly urge the adoption by the United States of the general plan of the Paris conference.

"What legislation is necessary on the part of the United States to adapt our coinage to the plan proposed?

"On this point your committee have consulted the Secretary of the Treasury and the director of the mint. The bill herewith reported is the result of this conference, and is all that is needed to secure the object proposed. The provisions in regard to silver coinage are urged by the director of the mint to secure harmony between the present market value of gold and silver; but this coinage can be regulated hereafter by the varying values of the two metals and without disturbing the sole legal standard of value for large sums. The general provisions of existing law relating to coinage are preserved.

"What provisions, if any, should be made for existing contracts? Shall they be discharged in the money made a legal tender at the date of the contracts or in the money provided for by this bill?

"In determining this question, a distinction must be made between public and private debts. All private contracts are made in view of the power of Congress to regulate the value of coins. This power has been repeatedly exercised by Congress, and in no case was any provision made for enforcing existing contracts in the old rather than the new standard. All property and contracts may be affected by legislation, but it is not presumed that in the exercise of its legislative power Congress will be controlled by either the debtor or creditor, but only by the general good. To continue a distinction between the old and the new coin in the payment of private debts would result in great inconvenience, while making the new coin a legal tender for all debts after a reasonable time

would enable our citizens to conform the great body of their contracts to the new standard. Such has been the practice not only in the United States but in other countries, where from time to time the standard of coin has been changed. Such was the principle adopted in the passage of the present legal-tender act, which if made applicable only to future contracts would have bankrupted a large portion of the active business men of the country, whose business compelled them to contract debts.

"It must be remembered that all private debts are now on the basis of legal-tender notes, of far less intrinsic value than the proposed coin. The depreciation of legal-tenders had the effect to diminish the value of all debts and the property of all creditors to the extent of the depreciation, and is only justifiable by the highest considerations of national safety. The resulting process of returning to specie basis will be far more severe on the debtor class. The depreciation of the burden of debt is a loss to a class generally benefited by the increased value of fixed property, and better able to bear the diminution of their capital, but an increase of the burden of the debt to the debtor class, by the payment of coin instead of depreciated paper money, often produces absolute ruin without fault in the debtor. All contracts are now on the legal-tender basis. Every private creditor would now take the new coin, and would be largely benefited by the changed medium of payment. The small relief of the debtor by the slightly diminished standard of coin will tend to that degree to lessen the unavoidable hardship to him of a return to specie payment. This relief would be especially just on the payment of long bonds issued by railroads and other corporations during or since the war, which were almost uniformly sold for depreciated paper money. Your committee therefore conclude, that as to all private debts or contracts, the only provision necessary in this bill is to postpone the operation of its legal-tender clause for a reasonable time after the passage of the act.

"Does not a different principle prevail as to public debts? As to public debts, the contract of loan is the only law that ought to affect the creditor until his debt is fully discharged. Congress, as the authorized agent of the American people, is one party to the contract, and it may no more vary the contract by subsequent acts than any other debtor may vary his contract. As to the public creditor, no legislative power stands between him and the exact performance of his contract. Public faith holds the scales between him and the United States, and the penalties for a breach of this faith are far more severe and disastrous to the nation than courts, constables, and sheriffs can be to the private debtor. These penalties are national dishonor and inability to borrow money in case of war or public distress, and the ultimate result is the sure and speedy decline of national power and prestige. When changes in our coin were made in 1834 and 1853, the United States had no public debt of any significance, and the precedents then made do not apply to the present time. Now the public debt is so large that a change of $3\frac{1}{2}$ per cent. in the value of our coin is a reduction of the public debt of \$90,000,000. So much of

this debt as exists in the form of legal-tender notes will be received and disbursed as money, and as its value for some time will be less than the new coin no provision need be made for it, but for so much of the debt as is payable, principal or interest, in coin of a specific weight and value, provision ought to be made for its exact discharge in that coin or its equivalent in the new. Your committee, therefore, propose an amendment to that effect.

"Your committee have been led to inquire whether, if the United States adopt the plan of the Paris conference, it will be adopted by other nations so as to accomplish the object proposed, of an international currency, of universal circulation throughout the civilized world. Upon this point we have the most satisfactory assurances. Since the Paris conference it has been adopted by Austria, and will, in all human probability, be adopted by the North German Confederation. A strong party in Great Britain, including many of her ablest statesmen, and the great body of her commercial classes, has urged the adoption of the plan, even in advance of the United States, and they concur in the opinion that, if adopted by the United States, Great Britain will be induced by her interests to modify her sovereign to the international standard. We have the highest authority for saying that Canada stands ready to adopt the plan the moment it is adopted by the United States. Different representatives of the South American States say those States will readily adopt it; so that upon Congress now rests the fate of a measure that, according to the opinion of eminent American statesmen, will shed unfading glory upon the age of its adoption, that will give to international law an international coinage, and will lead to a vast extension of the objects of international law common to Christian and civilized nations, thus binding the whole family of man by the same ties that are uniting and consolidating neighboring states. Your committee recommend the adoption of this measure with certain amendments, with the conviction that it will not only promote the local interests of the United States, but will subserve the general interests of all the nations who have already or may hereafter join in its adoption."

REPORT OF SENATOR MORGAN.

Mr. MORGAN, from the Committee on Finance, United States Senate, submitted the following report, to accompany Senate bill No. 217:

"In June last, while the Universal Exposition was in progress, an international monetary conference was held in Paris, under the presidency of the French minister for foreign affairs. Delegates from the several European nations were present. Mr. Samuel B. Ruggles represented the United States, and his report on the subject has been communicated to Congress, through the Department of State. From this it appears that a plan of monetary unification was there agreed upon, the general features of which are:

"1. A single standard, exclusively of gold.

"2. Coins of equal weight and diameter.

"3. Of equal quality, nine-tenths fine.

"4. The weight of the present 5-franc gold piece to be the unit, with its multiples. The issue by France of a new coin of the value and weight of 25 francs was recommended.

"5. The coins of each nation to continue to bear the names and emblems preferred by each, but to be legal tenders, public and private, in all.

"Senate bill 217 is designed to carry into effect this plan. Its passage would reduce the weight of our gold coin of $5 so as to agree with a French coin of 25 francs. It determines that other sizes and denominations shall be in due proportion of weight and fineness; and that foreign gold coin, conformed to this basis, shall be a legal tender, so long as the standard of weight and fineness are maintained. It requires that the value of gold coins shall be stated both in dollars and francs, and also in British terms, whenever Great Britain shall conform the pound sterling to the piece of $5.

"It conforms our silver coinage to the French valuation, and discontinues the silver pieces of one dollar, and five and three cents, and limits silver as a legal-tender to payments of $10. The 1st of January, 1869, is fixed as the period for the act to take effect.

"The reduction which this measure would effect in the present legal standard value of the gold coin of the United States would be at the rate of $3 50 in the hundred, and the reduction in the legal value of our silver coinage would be still more considerable.

"A change in our national coinage so grave as that proposed by the bill should be made only after the most mature deliberation. The circulating medium is a matter that directly concerns the affairs of every-day life, affecting not only the varied, intricate, and multiform interests of the people at home, to the minutest detail, but the relations of the nation with all other countries as well. The United States has a peculiar interest in such a question. It is a principal producer of the precious metals, and its geographical position, most favorable in view of impending commercial changes, renders it wise that we should be in no haste to fetter ourselves by any new international regulation based on an order of things belonging essentially to the past.

"Antecedent to any action by Congress on this subject we should carefully consider:

"I. The effect which the present abundant production of the precious metals, especially of gold, and the probable great increase in the supply, as mining facilities are improved and more generally applied, will have upon the purchasing power of these metals.

"II. The question of preserving such a relation between gold and silver as will retain the latter metal in free circulation, and continuance of the coinage of such denominations of silver as will serve to encourage American commerce with Mexico and with South American and Asiatic nations.

"III. The choice of a standard of unification which, all things consid-

ered, shall be least objectionable on account of fractional weights and intricacy of calculations.

"IV. Of delaying action until the Paris plan has been adopted by the commercial powers of Europe, and accepted by those nations on the western continent with whom we have commercial relations; or at least until their intentions in this regard are more fully known.

"V. Should not a period when the public mind is calm, more so than now, on the subject of monetary affairs, and when the national debt has become less formidable, be chosen for initiating a change?

"VI. The advisability of further popular discussion of the subject, to the end that the business as well as general public shall fully understand on what grounds so important a reduction in the value of our monetary unit, the dollar, is based, and the further advocacy of the merits of our own, so that, should any existing system be accepted, ours shall be more fully considered in that connection.

"Uniformity in coinage and also in weights and measures has been the pursuit of ages. Speculative systems have been advanced, only to be given up when subjected to practical tests, but the idea has never been abandoned. Nor was the recent occasion the first in which our government has been recommended, and that, too, with some urgency, three-quarters of a century ago, by the minister of that country, to adopt the French system of weights, measures, and coinage. But Congress, both then and since, has properly exercised great caution on a subject so full of complications. And the question of international unification yet remains an open one, balanced between the facilities it would afford to foreign commerce and the evils it would introduce into our domestic affairs. The adoption of some satisfactory and comprehensive plan, one to be adopted because it shall best subserve the interests of all, and not because it is or is not an existing one, may become desirable. If so, Congress will then be ready to take part in effecting such a measure. At present, however, there are questions of a very practical nature relative to the precious metals that begin to reveal themselves, and will soon press home upon us, which largely outweigh in importance the more theoretical one of assimilating all metallic circulations. Our situation as a commercial nation makes it prudent that on this, as on every question affecting home interests, we should remain free to mould our policy to meet occasions as they arise, following such course as shall appear best suited to develop our great, almost limitless, natural resources, increasing by gentle means the stream of commerce, but forcing nothing, rather than to hamper ourselves by international engagements or arbitrary regulations. An error now in fixing the values of gold and silver would injure this nation far more than any other. We may safely trust to the natural laws of commerce for the correction of any evils from which we have suffered. We have paid our seigniorage, we have met the demand for foreign exchange, but who shall say that the course of trade in the next ten years may not make an American city, New York

or San Francisco, the centre of exchange, and confer upon us the advantages so long enjoyed by European capital? Certainly no other nation can so well afford to wait.

"The movement proposed in the bill appears to be in the wrong direction. The standard value of gold coin should be increased—brought up to our own, rather than lowered. The reason must be obvious. Authorities unite in the conclusion that a fall in the value of the precious metals, in consequence of their rapidly increasing quantity, is inevitable. M. Chevalier recently estimated that the present yield of gold amounts, in 10 years, to about as much as the entire production during the 356 years which intervened between the date of the discovery of America and the year 1846, when the mines of California were found; and Mr. Cobden concluded that unless the cardinal rule of commerce, that quantity governs price, which applies infallibly to all other commodities, loses its force when gold is concerned, this continued and great increase must be followed by a reduction in its value.

"Ross Browne, in his recent report, says that the time is not far distant when the price of the precious metals, as compared with other proceeds of human labor, must fall. 'They are now increasing more rapidly than is the demand for them, and at the present rate of increase they would soon have to fall perceptibly; but the production will become much greater than it is. The vast improvements that have been made both in gold and silver mining, within the last 20 years, are applied only to a few mines. * * * If all the argentiferous lodes of Mexico, Peru, and Bolivia, known to be rich, were worked with the machinery used at Washoe, their yield would really flood the world. * * * New deposits of silver will be found, and innumerable rich lodes on the Pacific slope of the United States, not yet opened, will be worked with profit.'[1]

"The present enhanced prices of commodities and labor, the world over, measure, to some extent, the increasing quantity and consequent depreciation in the value of precious metals, and clearly indicate the direction the change is taking.

"The creditor, public and private, will be affected by this tendency, and while he must abide a depreciation which proceeds from natural causes, he may properly insist that artificial evils shall not be superadded.

"Of the increased production of gold the United States supplies more than half, and when the lines of railway now pushing across the continent shall penetrate the gold-bearing mountains and valleys of California and Oregon, and the western territories, mining improvements will be powerfully supplemented.

"The American continent, too, produces four-fifths of the silver of commerce. The mines of Nevada have already taken high rank, and Mexico alone supplies more than half the world's grand total. Our relations with the silver-producing people, geographically most favorable, are otherwise intimate. Manifestly our business intercourse with them can be

[1] See observations on this subject, Chapter [illegible]. — W. P. B.

lar ased, a fact especially true of Mexico, which, for well-known poli reasons, seeks the friendliest understanding. This must not be overlooked.

"These two streams of the precious metals, poured into the current of commerce in full volume, will produce perturbations marked and important. Other countries will be affected, but the United States will feel the effect first and more directly than any other.

"The Pacific railway will open to us the trade of China, Japan, India, and other oriental countries, of whose prepossessions we must not lose sight. For years, silver, for reasons not fully understood, has been the object of unusual demand among these Asiatic nations and now forms the almost universal medium of circulation, absorbing rapidly the silver of coinage. The erroneous proportion fixed between silver and gold by France, and which we are asked to copy, is denuding that country of the former metal. Our own monetary system, though less faulty, is not suitably adjusted in this respect. The silver dollar, for instance, a favorite coin of the native Indian and distant Asiatic, has well-nigh disappeared from domestic circulation, to reappear among the eastern peoples, with whom we more than ever seek close intimacy. As they prefer this piece we would do well to increase rather than discontinue its coinage, for we must not deprive ourselves of the advantages which its agency will afford, and 'it would be useless to send dollars to Asia inferior in weight and value to its well-known Spanish and Mexican prototype.'

"Mr. Ruggles says that nearly all the silver coined in the United States prior to 1858 has disappeared. A remedy is not to be found in the adoption of a system that undervalues this metal, for that commodity, like any other, shuns the market where not taken at its full value to find the more favorable one. It is a favorite metal, entering into all transactions of daily life, and deserves proper recognition in any monetary system.

"It is said that 'to promote the intercourse of nations with each other, uniformity of weights, coins, and measures of capacity is among the most efficacious agencies.' Our weights, coins, and measures now correspond much more nearly to the English than to the French standard. Our commerce with Great Britain is nine times greater than with France, and if the former does not adopt the Paris system of coinage—and we have no assurance that she will—the United States would certainly commit a serious error in passing this bill. No argument is needed to enforce this. And what of the rising communities? A properly adjusted coinage would stimulate commerce with those great parts of the continent lying south and southwest of us, with the West Indies, and the countless millions of trans-Pacific countries. We stand midway on the thoroughfare of traffic between these two widely-separated races. Our railways, canals, our natural highways, and merchant marine, may be made to control their carrying trade. But here, as everywhere else, a well-adjusted coinage becomes a wand of power in the hand of enterprise. Tokens are not wanting to mark the favor in which the United States are

r held in China. The usual honor recently conferred by that 'ernment upon a citizen of this country was not alone because of his ess as an ambassador at large, but was a mark as well of a friendly position towards this country. Future harmony of intercourse is ıred, too, by their adoption as a text-book in diplomatic correspond-e of a leading American authority on international law. Much might be said about the growing partiality of Japan towards this country; it is enough that the recent opening of certain ports indicates an ghtened change in the policies of these two old empires, of which ımerce, especially our own, is availing itself. There is nothing, in-d, in our foreign policy to create suspicion in the minds of the cau-s statesmen of Asia. We are non-aggressive; our vast domain 'es no motive for conquest; but, on the other hand, our fertile, eopled territory invites settlers, and our mines and the demand for r on the Pacific slope are rapidly drawing thitherward from Asia an 'easing tide of emigration, aiding not only in peopling that region, in establishing closer relations as well between individuals as a 'e liberal commerce between the nations.

Referring to the third inquiry, it may be asked, should a new stand-be adopted; is the French system more suitable for us than our own? Doubtless the French system 'embraces all the great and important ıciples of uniformity which can be applied to weights and measures, d coins as well,) but it is not yet complete. It is susceptible of many lifications and improvements.' And it is not inconsistent with the pect held toward so exalted a power as France, briefly for us to mine somewhat more closely certain features of this question. We producers; France, Belgium, Switzerland, and Italy, (who have pted the system,) are non-producers of the precious metals, and, refore, while adding little to the common stock of material for me-c currency, are not affected like us by an increase in gold and silver. are they likely to be influenced as we are to be, by other coming nges. Neither is there anything in the financial or commercial status France which entitles her monetary scheme to a preference over all ers in fixing a common coinage, unless, in itself, it is superior to all ers. This, in a practical sense, is not the fact. Writers represent it surrounded with difficulties, and an eminent French author calls it e worst of all systems.' Its basis is arbitrary, and the ratio it erves between gold and silver—one of gold for 15½ of silver by *weight*, one to 14 38-100 in *value*—is a confession of the erroneousness of the a. In theory, her coinage is metrical, and yet it is said that France not, nor never has had, a gold coin containing an even number of ms; or, practically, it is unmetrical.

The bill proposes 1612.9 milligrams, or 24 89-100 grains, for the gold ar. If adopted and we should still give to our silver dollar a weight value equal to the Mexican dollar, 416 grains, we should establish atio of value of gold to silver of 16 7-10 to 1, while 15 to 1 is as

high as it would be safe to go, and where, indeed, our own standard places it. 'If we consent to reduce our gold dollar, as proposed by the Paris conference, to 24.89 grains, we could not possibly coin a silver dollar that would be of any use to us in commerce,' for we should increase rather than diminish the weight of the gold dollar.

"On the subject of the French monetary unit, Mr. Dunning, superintendant of the United States assay office in New York, a competent authority, says:

"'The present weight of the gold 5-franc piece is not justified by any scientific reasons better than the mathematical accident that 620 of them weigh exactly a kilogram, a circumstance which has not the slightest practical importance. The fact is, this fractional and inconvenient weight, which the world is invited to adopt, was not fixed upon by the French themselves by design, but as the unavoidable result of a false theory.'

"Further, that after having fixed the ratio of gold as 1 to 15½, and having adjusted the weight of their silver coins in integral numbers, they were compelled to accept for the 5-franc gold piece the interminable decimal resulting from the division of 25 grams by 15.5, viz: 1.61290322580645. The awkwardness and inconvenience of this weight, he adds, 'can be best shown by giving the weight of a few of the gold coins of France, Great Britain, and the United States, as they will be if the proposed unit is adopted.' (See accompanying tables.)

"Mr. Dunning recommended for consideration a monetary unit of 1620 milligrams, for which he claims greater facility of making calculations than that proposed by the conference, and that it is also a compromise between the French and English coin weights, and would require a reduction on our own dollar of half a cent less than by the plan proposed in the bill. Mr. Dubois, assistant assayer of the Philadelphia mint, concurs in the views of Mr. Dunning.

"Other considerations aside, it may be said that until the leading nations represented at the Paris conference shall adopt a plan of unification, Congress may very properly decline to act; for anticipatory legislation, while disturbing relations existing between debtor and creditor, would accomplish no practical end. Mexico would not be partial to the French system, and Canada cannot be expected to accept it until its adoption by England. Unification to be desirable must be universal. Unless its advantages are palpable to commercial peoples of Europe, occupying contiguous territories, and whose intercommunication is constant, it cannot be of serious moment to us, to whom the change would be of but comparative usefulness.

"It has been urged as a reason for the early passage of a law to unify coinages, that commercial transactions with Europe would be facilitated thereby; and also that citizens of our country, in visiting Great Britain and the continent, would be spared losses and annoyances if we possessed uniformity. But it should be recollected that, in all large commercial transactions, gold coin is accounted by weight and not by tale—

a proceeding more speedy and equally just; and of the moneys used abroad by travellers from this country, probably more than 90 per cent. is carried in bills of exchange, a mode much safer and more convenient to the traveller, and which would be continued even if the bill became a law. The British delegates at the Paris meeting stated that, 'until it should be incontestibly demonstrated that the adoption of a new system offered superior advantages, justifying the abandonment of that which was approved by experience and rooted in the habits of the people, the British government could not take the initiative in assimilating its money with that of the nations of the continent.'

"A period of suspension of specie payment like the present, it has been stated, is a favorable one for inaugurating the change proposed by the bill. But the juncture is one marked by great differences of opinion in respect to the question of circulation, return to specie payments, and the public finances as a whole. A change in the value of coinage would but add to the embarrassments of the situation, and it may be remarked incidentally that the reduction of the legal value of the dollar would inure largely to the benefit of speculators in gold and hoarders of the precious metals, a fact that might seriously prejudice the measure in public estimation.

"If the nation were comparatively free from debt, Congress might with more propriety consider the question of changing the legal standard of coin; but one effect of reducing it as now proposed would be to deprive the public creditor of nearly $100,000,000 of his righful due. In the estimation of the committee such a proposition ought not to be entertained by Congress. It is proper here to say, that the delegate, Mr. Ruggles, who favors unification, has at no time thought it just to lower the value of our coin without making proper allowance to the holder of the several forms of national obligations.

"To be acceptable a change in our coinage must be a thing of clearly obvious advantage and proceed from the people. There has, however, been no popular expression in favor of the proposed plan, nor, indeed, any voluntary action in that direction whatever on the part of financial men, either in this country or elsewhere. If there has been any complaint in regard to our monetary system, the fact has not come to the knowledge of your committee. On the other hand, certain scientific bodies in our country have already protested against any ill-considered change in the American dollar. Our coinage is believed to be the simplest of any in circulation, and every way satisfactory for purposes of domestic commerce; it possesses special merits of every-day value, and should not, for light reasons, be exchanged where the advantages sought to be gained are mainly theoretical, engaging more properly the attention of the philosopher than the practical man. The instincts of our people lead them to believe that we are on the eve of important business changes, and we may therefore safely hold fast for the present to what experience has proven to be good, following only where clear indications may lead, and a future of great prosperity opens to our country. The war gave us

self-assertion of character, and removed many impediments to progress; it also proved our ability to originate means to ends. Its expensive lesson will be measurably lost if it fails to impress upon us the fact that we have a distinctive American policy to work out, one sufficiently free from the traditions of Europe to be suited to our peculiar situation and the genius of our enterprising countrymen. The people of the United States have been quick to avail themseves of their natural advantages. The public lands, not only, and the mines of precious metals, but our political institutions, have likewise powerfully operated in our favor, and will continue to do so with increasing force.

"Unification of the coinage, like all similar questions, should be taken up without bias and considered on the broad ground of national interest. At the proper time, when the country is restored to a normal financial condition, and the public ask a change in this regard, it may be well to appoint a commission of experts, carefully to consider the question in its various bearings. Reflection and further observation here and elsewhere may suggest the foundations for a better and more enduring system than the one now proposed, which in the nature of things is but a provisional one. Permanency is equally important with uniformity in our coinage.

"John Quincy Adams, who spent several years in studying the question of uniformity in weights and measures, and incidentally in that of coinage—indeed, the latter cannot be separated from the other two—says:

"'If there be one conclusion more clear than another, deducible from all the history of mankind, it is the danger of hasty and inconsiderate legislation upon weights and measures. From this conviction, the result of all inquiry is, that, while all the existing systems of metrology are very imperfect and susceptible of improvements, involving in no small degree the virtue and happiness of future ages; while the impression of this truth is profoundly and almost universally felt by the wise and powerful of the most enlightened nations of the globe; while the spirit of improvement is operating with an ardor, perseverance, and zeal, honorable to the human character, it is yet certain that, for the successful termination of all these labors, and the final accomplishment of the glorious object, permanent and universal uniformity, legislation is not alone competent. All trifling and partial attempts at change in our existing system, it is hoped, will be steadily discountenanced by Congress.'

"In this conclusion, which applies with even greater force to coinages, a fact fully recognized by Mr. Adams himself, the committee may safely now unite.

"For the reasons herein set forth it is respectfully recommended that the bill be not now passed into a law."

MR. DUNNING'S SUGGESTIONS.[1]

Mr. George F. Dunning, superintendent of the United States assay office in New York, in a letter to Mr. Dubois, of the Philadelphia mint,

[1] Appended to the report of Senator Morgan.

y 8, 1868, expresses his views as given below. In forwarding er to Senator Morgan, Mr. Dubois expresses his hearty concur-

he present weight of the gold 5-franc piece is not justified by any c reasons better than the mathematical accident that 620 weigh a kilogram, a circumstance which has not the slightest import- The fact is, this fractional and inconvenient weight, which the now invited to adopt, was not fixed upon by the French them- y design, but as the unavoidable result of a false theory. The coinage law of the 7th Germinal An. XI attempted to make a standard, and to fix the ratio of gold to silver as 1 to 15½. Then very sensibly adjusted the weights of their silver coins in integral s, 5 grains for the franc, and 25 grains for the 5-franc piece, they npelled to accept for the 5-franc gold piece the interminable deci- ilting from the division of 25 grains by 15.5, viz: 1.61290322580645. he awkwardness and inconvenience of this weight can best be y giving the weight of a few of the gold coins of France, Great and the United States, as they will be if the proposed unit is l:

Denominations of coins.	Existing weight of gold, 900 fine.	Proposed weight adopting 1612.9 milligrams for monetary units.	Equivalents in troy weight.
FRENCH COINS.	*Milligrams.*	*Milligrams.*	*Grains.*
...	1,612.903	*1,612.903	24.8908
e francs	8,064.516	*8,064.516	124.4544
d francs	32,258.064	*32,258.064	497.8177
BRITISH COINS.			
g piece	1,627.196	†1,612.903	24.8908
...	8,135.983	†8,064.516	124.4544
igns	40,679.915	†40,322.580	622.2721
UNITED STATES COINS.			
...	1,671.813	‡1,612.903	24.8908
...	8,359.064	‡8,064.516	124.4544
...	16,718.129	‡16,129.032	248.9088
le	33,436.258	‡32,258.065	497.8177
	Grams.	*Grams.*	*Grains.*
nd francs—French	322.5806	322.5806	4,978.1769
nd dollars—United States	1,671.8129	1,612.9032	24,890.8840
nd pounds sterling	8,135.9840	8,064,5161	124,454.4220

* No change. † Reduction 0.88 per cent. ‡ Reduction 3.52 per cent.

"3. The following table shows the weight of the same denominations of coin, &c., by adopting 1620 milligrams instead of 1612.9 for the monetary unit:

Denominations of coins.	Existing weights of gold, 900 fine.	Proposed weight, adopting 1620 milligrams for the monetary unit.	Equivalent in troy weight.
FRENCH COINS.	*Milligrams.*	*Milligrams.*	*Grains.*
Five francs	1,612.903	*1,620	25
Twenty-five francs	8,064.516	*8,100	125
One hundred francs	32,258.064	*32,400	500
BRITISH COINS.			
Four shilling piece	1,627.196	†1,620	25
Sovereign	8,135.983	†8,100	125
Five sovereigns	40,679.915	†40,500	625
UNITED STATES COINS.			
Dollar	1,671.813	‡1,620	25
Half eagle	8,359.064	‡8,100	125
Eagle	16,718.129	‡16,200	250
Double eagle	33,436.259	‡32,400	500
	Grams.	*Grams.*	
One thousand francs	322.580	324	5,000
One thousand dollars	1,671.813	1,620	25,000
One thousand pounds sterling	8,135.984	8,100	125,000

* Increase 0.44 per cent. † Reduction 0.44 per cent. ‡ Reduction 3.1 per cent.

"4. It will be noticed that the proposed unit of 1620 milligrams[1] has the merit of offering to Great Britain an even compromise of the difference between her present coinage and that of France, instead of a reduction of the British gold coins of $\frac{88}{100}$ per centum to make them equal to the French coins. The unit of 1620 milligrams exactly splits the difference, requiring an increase of the French coins of $\frac{44}{100}$ per centum, and a diminution of $\frac{44}{100}$ per centum in the British coins. This difference is so slight as hardly to call for any legal adjustments of existing contracts in either country; and while in the United States such an adjustment will doubtless be required, the proposed unit of 1620 makes the reduction of our coins almost one-half per centum less than would be effected by the unit of 1612.9. The exact difference as shown by the above tables is $\frac{42}{100}$ of one per centum.

"5. There is another very important advantage offered by the unit of 1620 milligrams, which you and all who have to do with mint calculations

[1] The exact equivalent of 1620 milligrams is in troy grains 25.0004; discarding the fraction of $\frac{4}{10000}$ involves a discrepancy in calculations of only one cent in $600, or [illegible] of one per cent.

will appreciate. I allude to the facility of making calculations. I will not attempt to exhibit the difficulties in calculating value from the standard weight when the relation is expressed in such interminable decimals as must result from the adoption of the unit 1612.9. But you will see at a glance the facility of dealing with the unit of 1620.

"The weight of 1,000 francs, or $200, or £40, at 1620 milligrams to the dollar, would be 324,000 milligrams. These values are readily deduced from the weight, as will be seen by the following examples:

France.	United States.	Great Britain.
Milligrams 324,000	Milligrams 324,000	Milligrams 324,000
÷9=36,000	÷ 9=36,000	÷90=3,600
÷9= 4,000	÷ 9= 4,000	÷90= £40
÷4= 1,000 francs.	÷20= $200	

"The above divisions are performed mentally without difficulty, and the rule of calculation is exceedingly simple. It is not at the mint alone, nor chiefly, that this facility of calculation will be appreciated. The transactions in coin and bullion the world over will be simplified by it. The experts at the mint can soon adapt themselves to any system, however complicated; but for the convenience of commerce the relation of weight to value in the coins of the world ought to be simple.

"6. If the troy system of weights is to be continued in this country and Great Britain, it will be immensely important that the monetary unit expressed in milligrams should be easily convertible into troy weight. A glance at the tables given above will show the discrepancy between the unit of 1612.9 and the troy system, and also the beautiful and almost marvellous harmony effected by the unit of 1620 milligrams.

"7. I trust, however, that Mr. Sherman's bill will contain a section making the use of the French system of weights obligatory in all the mints of the United States. This change would seem to be almost a necessary part of the plan of monetary unification of the world's coinage; and it would certainly be a judicious method of partially familiarizing the country with the metrical system, the universal adoption of which, even if not perfect, is so devoutly to be wished."

BILL INTRODUCED BY MR. KELLEY.

In the House of Representatives, July 21, 1868, Hon. William D. Kelley, of Pennsylvania, introduced a bill designed to promote the establishment of an international metrical system of coinage. It was read twice and referred to the Committee on Coinage, Weights, and Measures.[1] It proposes unification upon the decimal-metrical basis, and, as the whole bill is short and concise, it is here given entire:

"Whereas certain nations of Europe have adopted and have proposed to the rest of the world a coinage which was originally based upon that system of weights known as the metrical, but which, under the influence

[1] 40th Congress, 2d session, H. R. 1445.

of circumstances, has departed from its intended character; and whereas there is an assured expectation that this character of simple relationship to metrical weights will be ultimately returned to; and whereas the coinage of the United States can be brought into exact conformity with metrical weights by a change in its value, amounting to less than one-third of one per centum in the case of gold coins: Therefore,

"*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That the gold hereafter coined by the United States shall contain, for each dollar of denominational value, one and one-half grams of pure gold, and shall weigh, for each dollar, one and two-thirds grams, the proportion of alloy being thus kept as one to ten.

"SEC. 2. *And be it further enacted*, That such coins shall be legal tenders in payments arising from contracts made at any time after the first of January, eighteen hundred and sixty-nine, and that in case of all other payments, including those from the United States to its creditors, one thousand and three dollars of this new coinage shall be the legal equivalent of one thousand dollars of the old coinage of the United States, such being their actual relative values.

"SEC. 3. *And be it further enacted*, That such coins shall have stamped upon them, in addition to other devices, their weight in grams and the inscription, nine-tenths fine.

"SEC. 4. *And be it further enacted*, That the silver half dollars, and all smaller silver pieces, hereafter to be coined, shall consist of standard silver, nine-tenths fine, and shall be of the weight of twenty-five grams for each dollar of denominational value; and shall have their weight and fineness legibly stamped upon them; and shall be legal tenders for the payment of all sums not exceeding ten dollars."

The provisions of the foregoing bill are in accordance with the

VIEWS OF MR. E. B. ELLIOTT.

At the meeting of the American Association for the Advancement of Science at Chicago, in 1867 and 1868, Mr. E. B. Elliott, of Washington, D. C., read a paper upon "The Metrical Unification of International Coinage," in which was advocated, if any immediate change should be deemed necessary, the adoption of gold coins, which should have very simple relations with the *gram*, the metric unit of weight. The proposed French coinage did not have this simple relation, whereas the present weight of our own gold coins is almost strictly metrical, the variation being only about three mills in the dollar.

He also called attention to the important fact that the principal gold coins of the United States, Russia, Spain, and certain states of Central America, were so nearly metrical (giving the exact numerical relations in each case) that a change in the laws making them strictly so would prove only a nominal change, no recoinage being necessary. He also called attention to the fact, of still higher interest, that in 1857

ll Germany and Austria adopted a strictly metrical coinage of gold, by stablishing the Union crown and half-crown—the former containing preisely ten grams and the latter five grams of fine gold. These several ountries, which may be called countries of metrical coinage, have a poplation of about 200,000,000, a number greatly exceeding the population f the countries following the gold coinage of France, with its complex nd cumbrous relations to the metric unit of weight, the gram. He lluded also to the fact that several of the most prominent scientific men f France and Belgium—among others the eminent M. Chevalier—were arnestly opposed to retaining the existing coinage of those countries, imply on the ground of its want of harmony with their beautiful system f weights and measures.

These views of Mr. Elliott are exemplified by the following tabular exhibit of the relations of the existing and proposed systems of coinage:

Examples of existing and proposed systems compared.

Existing United States system closely approximates to the metrical system.		Metrical system, should be adopted.	System which it is thought should not be adopted.
9-10 of pure metal to 1-10 of alloy.		9-10 of pure metal to 1-10 of alloy.	9-10 of pure metal to 1-10 of alloy.
tandard gold.—Legal tender in payment of ll amounts.	($3) 5.015 grams.	($3) 5 grams	($3) 30-31 of 5 grams, or 4.8387 grams. (The gold legal tender 15-franc piece of France.)
atio of value of gold to silver.	14⅞ (nearly) to 1.	15 to 1	14⅞ (nearly) to 1.
tandard silver.—Fractional legal tender only in payment of mall amounts.[1]	($1) 24⅞ (nearly) grams.	($1) 25 grams (the legal tender silver 5-franc piece of France.)	($1) 23 2-10 (nearly) grams.

The fineness of both the gold and the silver coins in each of the abovementioned systems is *the same*, namely $\frac{9}{10}$ of pure metal to $\frac{1}{10}$ of alloy. he ratio of gold to silver assumed in each of the above cases is a safe ne, being below the market rate, and consequently rendering the silver oins of greater *nominal* value (expressed in gold values) than their actual market values. This is as it should be. The relative market value of old to silver for the past 14 years has averaged 15⅝ to one.

The second case—that of the metrical system—is obviously the most imple as regards the relation of the weight of the coins to the metrical nit of weight, the *gram*, as also in relation to the relative market values f gold and silver. The third case is the least simple of the three cases.

[1] Five dollars being the limit in the first case, and ten dollars in the second and third.

The simplicity of the German standard compared with others is still more clearly shown by the succeeding table:

Comparison of German and other standards.

Coins.	Present content of pure gold in grams.	Proposed content of pure gold in grams.		
		German, or metric.	French.	British.[1]
Three Union crowns of Germany (gold)	30. 0000	30	29. 032258+	29. 28954+
Twenty United States dollars (gold)	30. 0926+	30	29. 032258+	29. 28954+
One hundred French francs (gold)	29. 032258+	30	29. 032258+	29. 28954+
One thousand British pence (gold)	30. 5100—	30	29. 032258+	29. 28954+
Four British pounds or sovereigns (gold)	29. 28954+	30	29. 032258+	29. 28954+
Four Spanish doubloons each of 10 escudos (gold)	30. 1932	30	29. 032258+	29. 28954+
Five Russian half-imperials, each of 5 gold roubles, or 5,15 silver roubles	29. 9935	30	29. 032258+	29. 28954+

CONCLUSION.

In conclusion, the various systems and modifications discussed in the foregoing pages may be succinctly compared.

Upon the necessity and advantages of establishing a uniform system of money of account and coins, and upon the adoption of a single standard of gold $\frac{9}{10}$ths fine, there appears to be a general unanimity of opinion. The question to be decided then is: what system in the abstract is the best? or which of the proposed systems shall be adopted?

There is no doubt that by disregarding the existing systems and looking at the subject theoretically, a complete and universal decimal-metrical system could be devised that would be far more complete and satisfactory than any yet proposed; but as it would be practically impossible for the nations to unite upon such a theoretically perfect system, at least for a couple of generations, the best way is to arrive at unification by approximations, modifying the existing systems as little as possible, consistent with harmony, and thus avoiding great changes in value of moneys of account and in coin.

There are now three prominent systems of unification proposed:

1st. That of the Paris conference, embodied in the bill introduced by Senator Sherman.

2d. The system introduced in the Senate by Senator Morgan.

3d. The system embodied in the bill introduced in the House of Representatives by Hon. W. D. Kelley.

The system of the Paris conference requires the United States gold dollar to be diminished in weight from 1.671813 gram to 1.612903 gram, or 3.52 per cent., this being equivalent to \$3 52 in value on every \$100. Neither the gross weight of the coin nor the weight of the fine gold in the coin have either simple or convenient relations to the gram, and

[1] Basis of the sovereign.

interminable complex fraction is required to express the weight cimally.

The second system, or that suggested by Mr. Dunning and Senator organ, requires the dollar to be reduced in weight to 1.620 gram, or .0 per cent., being $3 10 in value on every $100. The fraction in this se is not interminable, and the weight is much more simply expressed an in the first system; and, moreover, it has simple relations with the oy weights, and can be easily converted from terms of one system to those of the other.

A third system requires the dollar to be reduced in weight to just one id two-thirds (1.666666+) gram, or $\frac{3}{10}$ of 1 per cent., being equivalent thirty cents ($0 30) in value on every $100. This may be called a etrical system; for, according to it $3 in gold would weigh exactly grams, and $6 would weigh 10 grams, and $10 16⅔ grams. The proosed modifications of existing weights, and the percentage of change, ot only of the dollar, but of the franc and of the pound, are shown and ompared in the annexed table.

Comparison of existing and proposed weights.

System proposed.	Proposed weight of pure gold contained, according to different systems.	Existing weight of gold 9-10 fine.	Proposed weight according to the different systems.	Difference of weight.	Per cent. of difference.
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Per cent.*
1.—PARIS CONFERENCE. (Sherman bill.)					
ive-franc piece	1.451713+	1.612903	1.612903+	0.000000	0.00
ollar of United States	1.451713+	1.671813	1.612903+	—0.058910	—3.52
ne-fifth of a £	1.451713+	1.627196	1.612903+	—0.004293	—0.88
2.—DUNNING SYSTEM.					
ive-franc piece	1.458	1.612903	1.620	+0.007097	+0.44
ollar of United States	1.458	1.671813	1.620	—0.051813	—3.10
ne-fifth of a £	1.458	1.627196	1.620	—0.007196	—0.44
3.—METRIC SYSTEM. (Kelley bill.)					
ive-franc piece	1.5	1.612903	*1.666666+	+0.043763	+2.08
ollar	1.5	1.671813	1.666666+	—0.005147	—0.30
ne-fifth of a £	1.5	1.627196	1.666666+	+0.039470	+2.43
ifty pence	1.5	1.691997	1.666666+	—0.028330	—1.67

* 1.666666+ = 1⅔ = 10-6.

APPENDIX A.

ADDITIONAL INFORMATION UPON THE PRODUCTION OF THE PRECIOUS METALS IN SEVERAL COUNTRIES.

Since the foregoing pages were printed, later statistics from Australia, Mexico, and California, have been received, and it is thus possible to present the following extracts supplemental to the statistical information already given:

AUSTRALIA.

NUMBER OF MINERS IN THE GOLD FIELDS.

The following table shows the total number of miners employed in the gold fields of Victoria from 1859 to 1867 inclusive:[1]

Year.	Alluvial miners.		Quartz miners.		Total miners.
	Europeans.	Chinese.	Europeans.	Chinese.	
1859	85, 249	25, 149	15, 342	24	125, 7[illegible]
1860	69, 724	20, 542	18, 268	28	108, 3[illegible]
1861	61, 516	24, 536	14, 403	8	100, 4[illegible]
1862	53, 042	23, 634	16, 675	28	93, 3[illegible]
1863	54, 050	23, 271	15, 661	12	92, 9[illegible]
1864	47, 234	21, 589	16, 155	8	84, 9[illegible]
1865	41, 226	20, 905	17, 298	28	79, 4[illegible]
1866	35, 816	20, 100	14, 844	34	70, 7[illegible]
1867	33, 407	15, 629	13, 970	47	63, 0[illegible]

"In 1866 there was a decrease in the number of quartz miners as compared with 1865 of 2,448, and it is a hopeful sign that this year it is so much smaller, and that in the two districts, Ballarat and Beechworth, where the decrease was so remarkable in 1866, there is this year, in both, a small increase.

"That the total number of miners in 1867 should be little more than half of the number for 1859 is, at the first view, somewhat perplexing, and seemingly irreconcilable with that appearance of prosperity which is observable in nearly every part of the colony; yet, when taken in connection with other statistics, those relating to roads, public works, municipalities, agriculture, and stock, it is even more surprising that so much should have been done for the permanent improvement of the

[1] This table and the following extracts are from the "Mineral Statistics of Victoria for the year 1868."

towns, in the construction of railways and roads, and in reclaiming waste lands, and that still more than 60,000 persons among a population of 660,000 should continue to give all their labor to the work of searching for gold."

On the 31st of December, 1867, there were 15,629 Chinese miners engaged in alluvial mining, and 47 in quartz mining, making a total of 15,675.

AVERAGE EARNINGS OF MINERS.

The following is a statement of the average earnings per man per annum for the past eight years, without distinction of classes.

Year	£	s.	d.
1860	79	9	3
1861	74	15	11
1862	67	17	10
1863	70	9	2
1864	74	1	9
1865	74	4	2
1866	80	8	3
1867	87	1	7

The mean for the eight years is £76 1*s.* nearly.

The average earnings per annum of the alluvial miners and quartz miners severally, (using the mean numbers employed throughout the year,) from 1863 to 1867 are as follows:

Average earnings of alluvial and quartz miners.

Year.	Alluvial miners.		Quartz miners.	
	Numbers.	Earnings per man per annum.	Numbers.	Earnings per man per annum.
		£ s. d.		£ s. d.
1863	76,343	59 7 $10\frac{1}{4}$	16,024	123 3 $9\frac{1}{4}$
1864	67,982	61 6 0	15,414	130 13 $9\frac{3}{4}$
1865	65,484	66 16 3	17,730	101 10 $5\frac{1}{4}$
1866	57,892	66 4 1	15,685	132 17 $4\frac{3}{4}$
1867	51,719	67 10 $7\frac{1}{4}$	14,138	158 11 $8\frac{3}{4}$

"These calculations must not be accepted as absolutely correct, though every endeavor has been made to get accurate data, both as regards the number of miners employed severally in alluvial mining and quartz mining and the total quantities of gold derived respectively from the alluviums and the veins.

"Looking at the estimates made by the mining surveyors and mining registrars of the total yields of gold from both sources, as given by them from year to year, it seems almost beyond doubt that a larger quantity of gold is raised in the colony than is recorded in the returns. What becomes of it or how it is removed is inexplicable.

"The estimates of the officers are based on information given (confidentially) by the bank managers and the gold buyers in their several divisions; and making every allowance for discrepancies and errors, it still seems probable that the total quantity of gold, as recorded every year, is below the quantity actually raised.

"With respect to the earnings of the quartz miners the difficulty is not great because there is some check, though an insufficient one, on the estimated quantity of gold got. This cannot fall below, nor very greatly exceed the amount given in table No. 20, [viz., 948,850$\frac{12}{20}$ tons yielded 498,677 ounces 12 pennyweights, an average of 10 pennyweights, 12.2 grains per ton,] which shows the quantities of gold actually obtained from certain parcels of quartz crushed. The average earnings of the quartz miner would amount to £141 1*s*. 9¼*d*., if we assumed that no more was produced than is set down in that table; but it is well known that it is at present impossible to get returns from all the mills.

"It is satisfactory to note that, in whatever way this matter is tested, this fact is indisputable, that both from the alluvial mines and the quartz veins the average returns per man per annum are higher this year than they have been at any time during the past eight years."

MACHINERY FOR WORKING ALLUVIAL AND QUARTZ MINES.

"The tables relating to machinery do not give a fair indication of the improvements which have been made in the appliances for the extraction of gold from quartz veins. The total number of engines employed remains nearly as it was last year; but many small additions to apparatus, which it is not possible to comprise in a return, have been made in several of the larger establishments with good results."

The number of steam engines and stamp-heads for reducing vein-stuff for the past four years are as follows:

Mining machinery.

Year.	ALLUVIAL MINING. Steam engines employed in winding, pumping, puddling, &c.		QUARTZ MINING. Steam engines employed in winding, crushing, &c.		
	Number.	Aggregate horse-power.	Number.	Aggregate horse-power.	No. of stamp-heads.
1864	441	6,891	447	7,746	4,575
1865	473	8,2 8	491	8,606	5,119
1866	480	9,981	510	9,231	5,437
1867	470	9,863	532	9,955	5,529

According to the returns made by the mining registrars and surveyors there are 2,381 auriferous quartz reefs already opened, and 868¼ square miles of auriferous ground which have been worked more or less.

YIELD OF QUARTZ PER TON.

The following table shows the average yield per ton for each district for the past eight years:

District.	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.
	Dwts. grs.	*Dwts. grs.*	*Dwts. grs.*	*Dwts. grs.*	*Dwts. grs.*	*Dwts. grs.*	*Dwts. grs.*	*Dwts. grs.*
Ballarat	12 13	8 0	5 15	4 22	4 16.4	5 3.9	4 21	6 21.7
Beechworth	74 9	33 23	21 12	49 7	23 16.4	27 10.3	18 3.7	12 19.2
Sandhurst	47 1	30 9	14 2	26 16	9 16.9	13 11.8	9 16.8	9 2.2
Maryborough	27 21	22 13	18 7	13 9	12 5.8	10 22.1	11 7.3	10 6.2
Castlemaine	22 11	16 19	15 7	14 3	13 23.7	13 4.9	13 18.5	11 12.4
Ararat	31 15	19 13	14 6	10 5	11 4.4	13 16.7	15 11.9	17 17.1
Gipp's Land	....	....	....	....	....	....	....	27 5.6

"The large yields of 1860 and 1861 are explained when the tables to which the averages relate are contrasted with those for the following years. At first it was not possible to get returns from many of the mills, and those obtained had reference to parcels which gave exceptional results.

"The average yield during the past year has varied from 3 pennyweights 6.9 grains, in the southern division of the Ballarat district, to 4 ounces 8 pennyweights 13.5 grains, in the Jamieson south subdivision of the Beechworth district."

Since the first publication of the official mining statistics of Victoria, information has been received concerning an aggregate of 4,925,440$\frac{11}{20}$ tons of quartz, which have been crushed and the average yield of their total was 11 pennyweights 16.14 grains per ton. The average for 1867 of 948,850$\frac{13}{20}$ tons, in various districts was 10 pennyweights 12.2 grains.

The average yield of gold from certain parcels of quartz tailings cement "mulloch," &c., crushed in 1867, in the several mining districts, range from 2 pennyweights 16.3 grains, to 5 pennyweights 12 grains, and averaged 3 pennyweights 19 grains.

COST OF CRUSHING QUARTZ AND CEMENT.

The prices charged for crushing quartz and cement in the several districts during the last quarter of 1867, ranged from 4 shillings to £1 10*s*. The price of gold per ounce for the same period ranged from £3, to £4 1*s*. 6*d*. The quantity of gold obtained during the year (1867) was, approximately:

	Ounces.
From quartz veins,	560, 527
From alluvial washings	873, 160$\frac{6}{20}$
Total gold extracted	1, 433, 687$\frac{6}{20}$

There were, December, 1867, 2,300 miles aggregate length of water races, the approximate cost of which was £321,903.

EXTRACTION OF GOLD FROM AURIFEROUS PYRITES.

An interesting question, now engaging a large share of public attention, is the extraction of gold from auriferous pyrites.

The following statements, which bear upon it, are taken from the reports of the mining surveyors and registrars:

"In the Creswick division 165 tons of pyrites yielded 751 ounces 8 pennyweights of gold, or an average of 4 ounces 11 pennyweights 189 grains per ton.

"In the Crooked River subdivision two tons gave 94 ounces 14 pennyweights, or at the rate of 48 ounces 7 pennyweights per ton.

"There is a machine at Twist's creek which has been erected for the purpose of operating on auriferous pyrites, but no returns have yet been received.

"From the Blackwood division a number of samples have been sent to Melbourne, and the yield is said to be from £17 to £32 per ton.

"In the Buckland division one miner collects pyrites from the old tail-races. He has not kept a record of the yields, but he estimates that, on an average, 1 ton of the tailings yields 1 ounce of gold.

"In the Sandhurst division the manager of the Comet company obtained gold at the rate of 3 or 4 ounces per ton from a few tons of *blanketings* put through an arrastra. Several companies are saving their tailings; and, as many of the reefs in this division contain large quantities of auriferous pyrites, a fair field is open to the practical chemist and experienced miner."

Mr. H. A. Thompson, who has directed much attention to the extraction of gold from pyrites, communicated the result of his system, as it is in operation at Clunes, in a letter to the *Bendigo Advertiser*.

They are thus stated:

Quantity of concentrated pyrites operated on	268 tons.
Amount of gold obtained	796 ozs. 8 dwts.
Value of gold	£3,169 7*s.* 9*d.*
Cost of operating	£800 4*s.*
Profit on one year's work	£2,369 3*s.* 9*d.*
Proportion of total gold contents extracted	86 per cent.
Leaving loss	14 per cent.

The average return of gold is therefore about 3 ounces per ton, and the cost of extracting the gold £3 per ton, or £1 per ounce.

The prices per ton for crushing quartz, &c., have ranged from 4*s.* to £1 10*s.*

The lowest prices obtain in the districts of Ballarat and Castlemaine, and the highest in Beechworth and Gipp's Land.

Additional particulars—touching the weight and cost of stamp-heads and shanks or lifters, the quantities of quartz crushed per head per diem, the number of holes per square inch in the gratings, the quantity of water used, and the quantity of quicksilver used and the quantity lost—are

for the first time, included in these statistics. They have reference only to the principal gold mines in the several districts; but they will not on that account be less useful.

WEIGHT AND COST OF STAMPS.

"In the Ballarat mining district the stamp-heads and shanks or lifters vary in weight from 4 hundred weight to 8 hundred weight 2 quarters, and the cost is from £3 17*s.* 6*d.* to £15 10*s.* The height the stamp-head falls ranges from 7 to 10 inches. The number of strokes made by stamp-heads per minute is from 50 to 85. The quantity of quartz crushed per head per diem of 24 hours varies from 1 ton to 4 tons. The number of holes per square inch in the gratings used is from 40 to 200.—(The latter number is made use of by the Victoria company at Clunes; the grating is fixed at the back of the stamper-box.) The horse-power required to work each stamper is from 1 to 2. The quantity of water used per stamp-head in crushing varies from 950 gallons to 8,640 gallons per diem of 24 hours. The quantity of mercury used in the ripples per stamper is from 5 to 75 pounds. The quantity of mercury lost per stamp-head per week varies from 1 ounce to 8 ounces.

"In the Beechworth mining district the stamp-heads and shanks or lifters vary in weight from 4 hundred weight, 1 quarter, 17 pounds to 7 hundred weight, 3 quarters, and the cost from £5 3*s.* 6*d.* to £13 per head. The height the stamp-heads fall varies from 5 inches to 14 inches. The number of strokes made by the stamp-heads per minute is from 40 to 90. The quantity crushed per head per diem of 14 hours ranges from 16 hundred weight to 4 tons. The number of holes per square inch in the gratings used is from 60 to 140. The horse-power required to work each stamp-head is from 0.75 to 1.50. The quantity of water used per stamp-head in crushing varies from 720 gallons to 11,520 gallons per diem of 24 hours. The quantity of mercury used in the ripples per stamper is from 5 to 70 pounds. The quantity of mercury lost per stamp-head per week varies from ½ ounce to 8 ounces.

"In the Sandhurst mining district the stamp-heads and shanks or lifters vary in weight from 5 hundred weight to 8 hundred weight, and the cost from £4 5*s.* to £8 11*s.* The height the stamp-heads fall varies from 6 to 18 inches. The number of strokes made by stamp-heads per minute is from 25 to 75. The quantity of quartz crushed per head per diem of 24 hours ranges from 18 hundred weight to 3 tons 3 quarters. The number of holes per square inch in the gratings used is from 64 to 140. The horse-power required to work each stamp-head is from 0.66 to 2. The quantity of water used per stamp-head in crushing varies from 4,000 gallons to 8,640 gallons per diem of 24 hours. The quantity of mercury used in the ripples per stamper is from 10 to 40 pounds. The quantity of mercury lost per stamp-head per week varies from ½ ounce to 5½ ounces.

"In the Maryborough mining district the stamp-heads and shanks or lifters vary in weight from 4 hundred weight 2 quarters to 8 hundred

weight, and the cost from £4 18s. 6d. to £8 14s. 6d. The height the stamp-heads fall varies from 6 to 22 inches. The number of strokes made by stamp-heads per minute is from 50 to 75. The quantity of quartz crushed per head per diem of 24 hours ranges from 1 ton to 3 tons. The number of holes per square inch in the gratings used is from 70 to 144. The horse-power required to work each stamp-head is from 0.50 to 2.50. The quantity of water used per stamp-head in crushing varies from 900 to 8,640 gallons per diem of 24 hours. The quantity of mercury used in the ripples per stamper is from 3 to 30 pounds. The quantity of mercury lost per stamp-head per week varies from 1⅔ ounces to 8 ounces.

"In the Castlemaine mining district the stamp-heads and shanks or lifters vary in weight from 4 hundred weight 2 quarters to 8 hundred weight, and the cost from £4 2s. 6d. to £21 11s. 6d. The height the stamp-heads fall varies from 6 to 15 inches. The number of strokes made by stamp-heads per minute is from 35 to 75. The quantity of quartz crushed per head per diem of 24 hours ranges from 1 ton to 3 tons 5 hundred weight. The number of holes per square inch in the gratings used is from 40 to 144. The horse-power required to work each stamp-head is from 0.50 to 2. The quantity of water used per stamp-head in crushing varies from 4,800 to 12,960 gallons per diem of 24 hours. The quantity of mercury used in the ripples per stamper is from 6 to 40 pounds. The quantity of mercury lost per stamp-head per week varies from ¼ ounce to 24 ounces.

"In the Ararat mining district the stamp-heads and shanks or lifters vary in weight from 5 hundred to 6 hundred weight 3 quarters, and the cost from from £7 to £8 8s. The height the stamp-heads fall varies from 7½ to 10 inches. The number of strokes made by stamp-heads per minute is from 60 to 72. The quantity of quartz crushed per head per diem of 24 hours ranges from 1 ton 5 hundred weight to 1 ton 10 hundred weight. The number of holes per square inch in the gratings used is from 90 to 120. The horse-power required to work each stamp-head is 0.75. The quantity of water used per stamp-head in crushing varies from 4,320 to 12,960 gallons per diem of 24 hours. The quantity of mercury used in the ripples per stamper is from 6 to 47 pounds. The quantity of mercury lost per stamp-head per week varies from ½ ounce to 7 ounces.

"In the Gipp's Land mining district the stamp-heads and shanks or lifters vary in weight from 6 hundred weight to 7 hundred weight 2 quarters, and the cost from £5 5s. to £40. The height the stamp-heads fall varies from 7 to 10 inches. The number of strokes made by stamp-heads per minute is from 60 to 80. The quantity of quartz crushed per head per diem of 24 hours ranges from 1 ton 10 hundred weight to 2 tons 1 hundred weight. The number of holes per square inch in the gratings used is from 70 to 250. The horse-power required to work each stamp-head is from 0.75 to 1.50. The quantity of water used per stamp-head in crushing varies from 1,600 gallons to 25,000 gallons[1] per diem of 24 hours.

[1] This is excessive.

'he quantity of mercury used in the ripples per stamper is from 10 to 37 ounds. The quantity of mercury lost per stamp-head per week varies rom ½ ounce to 32 ounces."

MEXICO.

PRESENT CONDITION OF MINING FOR SILVER AND GOLD.

By the kindness of E. L. Plumb, esq., acting minister of the United States to Mexico, I am able to add some late and valuable information :o that already given in Chapter V upon the production of silver and ;old in Mexico.

It appears from the recent report of the minister of industry that the roduction of the precious metals is greater than is indicated by the data nd estimates obtained from other sources, upon which the statements ;iven on page 156 of this report from the Statesman's Year Book are ased. Instead of \$12,500,000 to \$13,000,000, the production is conidered as not less than \$20,000,000 for silver and gold. This estimate is ased upon the returns of the coinage at the various mints, full returns rom which are given, showing that in the 10 years from 1858 to 1867, incluive, (including also the returns for one year, 1857, for one mint, Durango,) he aggregate coinage has been \$173,496,910. To this may be added an stimated amount for the state of Sonora of \$10,000,000 more, thus naking an average of over \$18,000,000 a year. An abstract of these nint returns is here given. The statement of coinage given on page 57 is for one mint only, that of Guanajuato.

;old and silver coinage at the mints of Mexico, from 1858 *to* 1867, *inclusive, ten years, including coinage at Durango for* 1857.

Name of mint.	Silver.	Gold.	Total.
aliacan, from 1858–1867, 10 years	\$7,214,540 37	\$1,559,856 00	\$8,774,396 37
hihuahua, from 1858–1867, 10 years	5,483,000 00	382,768 00	5,865,768 00
'urango, from 1857–1867, 11 years	6,785,170 25	368,565 00	7,153,735 25
uadalajara, from 1858–1867, 10 years	3,650,364 36	96,252 00	3,746,616 36
uanajuato, from 1858–1867, 10 years			49,114,840 00
an Luis Potosi, from 1858–1867, 10 years			14,170,656 50
lexico, from 1858–1867, 10 years	38,380,564 50	1,787,646 00	40,168,210 50
axaca, from 1858–1867, 10 years	1,189,921 75	335,313 60	1,525,231 35
acatecas, from 1858–1867, 10 years	42,276,448 00	701,008 00	42,977,456 00
Total amount of gold and silver			173,496,910 43

The silver and gold coinage at the nine mints for 1867 amounted to 18,278,866.

The ratio per cent. of the silver to the gold coinage as far as shown bove is as 95.26 to 4.74.

The following are the totals of coinage of the Mexican mints for each ear since the war of independence up to 1858, thus, with the foregoing able, completing the exhibit of the coinage up to 1868, with the excepon of one year, (1857.)

Coinage of the Mexican mints.

1822	$9,816,525	1840	$13,162,567
1823	9,785,024	1841	13,475,632
1824	9,560,472	1842	13,800,266
1825	8,927,658	1843	12,075,698
1826	8,177,471	1844	13,671,230
1827	10,395,291	1845	15,236,717
1828	10,237,448	1846	15,414,453
1829	12,164,483	1847	17,636,115
1830	11,608,871	1848	19,203,688
1831	10,258,299	1849	19,386,570
1832	12,216,460	1850	19,389,336
1833	12,642,876	1851	17,481,934
1834	12,972,148	1852	18,190,514
1835	11,815,687	1853	17,028,921
1836	11,530,622	1854	17,249,946
1837	11,470,509	1855	17,593,475
1838	13,084,267	1856	19,205,656
1839	12,525,085		

This shows a total from the independence of Mexico in 1822 to 1857 of $478,392,014, and, if we allow $18,000,000 for 1857, a total to 1868 of $680,000,000, in round numbers.

The amount of coin in circulation was estimated in 1805 at over $78,000,000, and Lempriere, in 1862, estimated it at $70,000,000.

In taking the amount of coinage as an indication of the total production of Mexico, it is to be considered that a part of this coinage may consist of a recoinage of old and worn coin, and of bullion which may have passed through the mints before. But these sources of error are more than counterbalanced by the amount of silver secretly exported, or smuggled out of the country along both coasts, and on the frontier, which is acknowledged to be very large. Lempriere, with the official documents and information before him, states that the total value of gold and silver legally exported since the conquest down to 1858, a period of 339 years, is estimated at $4,640,204,889. This gives $13,687,920 as the average legal exports of the precious metals per annum from the landing of Cortez to 1858.[1]

REDUCTION WORKS OF PACHUCA.

The following tabular statement shows the quantity of ores worked, the costs, and yield, at several of the mills in the district. There are other establishments for working ores at San Antonio, La Purissima, De Enmedio, De Jesus, Guadalupe, and San Antonia Regla.

[1] Lempriere's Mexico, p. 215. From information supplied by the Ministerio de Fomento and E. L. Plumb, esq.

	Names of the works.	Proprietors.	Number of cargas reduced in three months.	Cost per monton of 30 quintals.	Method employed.	Yield per monton.		Percentage of loss.	Loss of quicksilver per mark of silver produced.	Consumption of material per monton.		
						By assay.	By working.			Arrobas of salt.	Sulphate of copper.	Cargas of timber.
						Ms.	*Ms.*	*Ms.*	*Ozs.*			
Pachuca	Loreto	Comp. Inglesa	11, 430	$37 56	Patio	13. 72	12. 66	7. 73	12. 66	6. 84	0. 95	0. 36
Do	La Purisima	Sr. Jecker	1, 463	37 56	do	19. 14	12. 66	7. 73	12. 35			
Do	La Luzchica	Tello y Comp		37 56	do	Parada	Parada	7. 73	12. 35	6. 84	0. 95	0. 36
Real del Monte	Guerrero	Comp. Inglesa										
Omitlan	El Aviadero	do										
Do	Sanchez	do	10, 300	30 96	Barrels	13. 95	12. 89	7. 60	4. 82	7. 35	0. 95	7. 77
Do	Velasco	do	22, 800	27 71	do	12. 24	10. 42	14. 87	5. 45	8. 33	0. 95	7. 61
Velasco	Peñafiel	do									0. 95	7. 61
Huasca	San Miguel	do	11, 910	28 59	Barrels	12. 83	9. 71	24. 32	2. 42	6. 11	0. 95	9. 95
Do	Regla	do	13, 150	26 73	Patio y fun	13. 90	12. 45	10. 43	13. 29	6. 84	0. 79	9. 95
El Chico	San Cayetano	Neg. de Arévalo	2, 850	18 00	do	12. 00	9. 00	25. 00	10. 55	7. 50	3. 00	9. 95
Do	San Diego	Sr. Mancera	1, 900	18 00	Patio	12. 00						
Do	San Pascual	Sr. Rule	300	18 00	do							
Do	San Francisco	Sr. Villamil	720	18 00	do							
Do	Orizavita	Sres. Villamil	210	18 00	do							

[1] Extract from Memoria de los Trabajos Ejecutados por la Commission Cientifica de Pachuca, Mexico, 1865.

ENCOURAGEMENT OF MINING IN MEXICO.

The comparatively depressed condition of mining in Mexico is exciting much attention there at the present time, and it is proposed to abolish some of the taxes upon mining, and to permit the free exportation of ores of silver and other metals. An elaborate report has been made upon this subject by a commission appointed for the purpose by the Junta de Mineria. As this report contains much valuable general information upon the industry of mining in Mexico, and its relations to all other industries, copious extracts have been translated and are here presented.

REPORT OF THE COMMITTEE ON MINING TAXES.[1]

[Translation, abridged.]

It is a fixed fact, demonstrated by the past and attested by the present, that mining constitutes the chief resource of Mexico. But this truth is even now denied by some, who contend that agriculture is the real source of the wealth of Mexico; by others who say that manufacturing is the basis of our prosperity; and even by a few who assert that Mexico ought to be sustained by commerce. It has been declared by some that the protection to mining interests has prevented the development of other industries. Our miners have been blamed for digging gold and silver, to the neglect of other mineral wealth, such as coal, which is worth more to some countries than our mines of precious metals are to us.

The chief business of our country is mining for gold and silver. This is not because it has been encouraged by the different administrations of the country, but because it is almost the only profitable business. Though we have fertile lands, indigenous fruits, varied climates, and extensive sea-coasts, the configuration of the land is such that these advantages cannot be readily utilized.

The central table-land of our country is separated from either sea-coast by rugged mountains and deep ravines, breaking it into longitudinal zones of different temperatures and varied productions; but this fact almost cuts off communication between these zones and the sea-coast east and west.

While such natural difficulties exist, increased by territorial extent, manufactures and agriculture cannot thrive; because the cost of transport is so great, we cannot contend with foreign competition, and our vegetable products must be confined to home consumption.

But such is not the case with the precious metals, particularly silver, for no country can rival Mexico in the yield of that metal; and then, gold and silver are so valuable, compared to bulk and weight, that transportation is not expensive. Such are the advantages of the mining of

[1] Dictamen de la comision de impuestos nombrada por la junta de mineria que el ministerio de hacienda convoco en su circular de 18 de Marzo de 1868.

precious metals, and this explains why they have always formed ir-fifths of the revenues, not reckoning the contraband export, which s always been considerable.

Mexico has vast mines of iron, zinc, lead, tin and copper. There is ough iron in Mexico to supply the whole world for many years, if we d the material for smelting it, and the means of transportation. For s reason, many States have to use imported iron. The other common tals are little used in the country, and only small quantities of them exported from mines near the coast and on the frontier.

Gold and silver mining requires but little fuel, and less machinery. e mining of these metals can be carried on wherever a mule can go th quicksilver, and wherever the sun shines warm enough to facilitate work; whereas iron mines require much machinery and vast labor, l can only be made profitable where water or steam can be conveni-ly used; and everybody knows that wood and water are the chief nts of our otherwise favored land.

Stone coal has been discovered in many parts of the republic, and ist eventually take the place of wood as a fuel in our country. The ength of nations is now estimated by the quantity of fuel they can nmand; that being so, our coal mines must soon become more valua- to us than our silver mines. But to profit by this new mineral wealth, need cheap labor and easy transport.

Iron and coal are necessary to manufactures, and they cannot increase long as we have to import machinery. To import machinery to advan-ge is almost impossible, as the land transport is double and often quad-le the original cost of the machinery.

From what we have said, it is evident that agriculture and manufac-es must be limited to home consumption; and for these reasons mining st have the advantage over all other industries.

Now let us consider the conditions of this internal consumption. If duction and consumption are only exchanges of excesses between ferent kinds of industry, the one most favored by circumstances uld be most encouraged, for the benefit it gives indirectly to others; l in our country this is mining, as we will endeavor to demonstrate in course of this report.

But even this internal exchange of the products of the country is very ited on account of bad roads; and on this account agriculture and nufactures are principally confined to a limited circuit near flourish- mines, and depend entirely upon the success of the mining interests. occasional drought or an early frost, injuring the particular crop of a tain mining region, will bring in agricultural products from adjoining tricts, but this does not often happen.

Now, as the different mining districts cannot be readily connected by d roads, we must increase the number of the districts, and encourage ning in every way, principally by awarding prizes for discoveries of nes or new modes of working them. The mining board should pre-

sent a petition to this effect to the general government, and also ask for the opening of good roads. If Congress had applied half the war appropriations for this purpose, it would have converted an unproductive fund into a source of public wealth.

In course of time good roads would have an immense influence upon our different industries, and free agriculture from its strict dependence upon mining. If our agricultural produce could be conveniently exported, the fertile regions of Mexico, now as sterile as African deserts, would smile in their abundance. With passable roads, our iron, coal and lead would become valuable, and give life to all arts and trades exercised among us. But before such a lovely perspective can be realized, gold and silver mining must continue to be the principal, if not the exclusive industry of our country, and our rise or fall will depend upon it. Let us now glance at the state of mining industry in our country from the earliest times.

In 1803 Humboldt said, "There are about 500 mining districts in the kingdom of New Spain, and the number of mines worked in them amounts to 3,000." He then goes on to enumerate the mines and give their situation; and though our territory has been greatly diminished, all those mines mentioned by the distinguished traveller yet belong to us. Whether that be true or not, it is certain that our mines have neither diminished in number nor in yield of the precious metals.

The same author classified the mining districts thus, beginning at the richest: Zacatecas, Catorce, Guanajuato, Guarisamey, Durango, Rosario, Tasco, Zacualpam, Temascaltepec, Bolaños, Jalisco, Sonora, Real del Monte, Pachuca, Zimapan, Cosiguiriachi, Parral, Batopilas, Oaxaca, and Villalta.

Since Humboldt's time the same mines have continued to be worked, and the central groups have always yielded most. Pachuca has prospered exceedingly. We find from these data that many of our old mines have not been worked since that time; and as population has decreased on the borders of our country, few new discoveries have been made. Soon after Upper California ceased to belong to us we were grieved to hear of the gold and cinnabar discovered there that we had not found.

The mineral wealth of the States of Durango, Sonora, and Chihuahua is greater than all the rest of our territory, judging from certain indications; and it will be developed as soon as settlers are protected from the scalping knives of the savages. To effect this Congress has recently passed a law establishing military colonies in those regions; and if the design be properly accomplished it may prove a protection to adventurous miners, and thus greatly augment the wealth of the country.

Even in those mines that have long been worked, the maximum richness of the veins has not been reached, owing to the difficulty, danger, and expense of working under ground. In this difficult labor many years often pass and much money spent before the mines begin to pay. The

rsons who open mines are rarely paid for their toil. It is said that ines opened in the 16th and 17th centuries, and worked at intervals nce, did not begin to yield a profit till the 18th or 19th century. The rdness of the material to be excavated, or its extreme softness, or too uch water, make the labor so expensive that a generation passes before paying part of a vein is reached.

If we consider the want of skill in working many mines, or the want ' proper economy, causing so many to fail in first enterprises, we are ot surprised that so few attempts are made to open new mines. Though miner be ruined in fortune, his money has kept many alive, does genal good, and benefits a future generation. For these reasons the callg of a miner has been considered as noble and meritorious by those vernments that prefer general good to individual profit, and look to e future as well as to the present. A love for mining was once looked pon as a kind of madness, and men who were afflicted by it lost credit. ny farmer or merchant who wished to take an interest in a mining iterprise had to do it secretly, for fear of ruining his business.

Rich as the ores of old mines were, they could not last, because the penses of working the mines became too great. Now we think it the ity of a provident and careful government to encourage the opening d working of new mines in every way; they should be liberal and genous to beginners, and put no impediments in their way; they should exempt from all tax on what they consume; and the government ould do all in its power to make a new mine pay expenses from the ginning, though the ores be poor.

It is also a difficult task to re-open mines that have once been worked; ater often fills the shafts, masses of rubbish stop the drifts, timber suprts have rotted and fallen in the tunnels, landslides have encumbered e way, and often bad air stops respiration. It was for such reasons at mining laws have always opposed the abandonment of a mine, and quired plans and specifications of all mines to be filed in the public chives, and granted so many privileges to those who re-open abandoned ines. An abandoned mine requires almost as much labor as a new e; neglected work of no other kind suffers so much.

With little encouragement to mining, it is no wonder that only old d well-known mines have been worked up to the present day. If the vernment wishes all kinds of industry to prosper it must encourage ining.

Mr. Elhuyar, in his memorial on the influence of mining upon agriculre, manufactures, population, and civilization in New Spain, written ring the first revolution, in colonial times, was so satisfied of the portance of mining to the country that he proposed to fill the empty tional treasury and furnish everything free to the miners if the colonial vernment would give him the administration of mines.

Persons not familiar with mining think the ores of mines very rich; ey suppose a bar of silver of 136 marks comes out of a few quintals of

ore. If this were the case the miner would have all the profits, and none would go to the state, or benefit other industries. Few have a just idea of the vast amount of ore and labor used to produce the 2,500,000 marks of silver yielded annually by our mines. The famous Valenciana mine of Guanajuato, in the best times, only yielded five ounces of silver to one quintal of ore; at Pachuca and Real del Monte it gave only three ounces per quintal; the best ores of Zacatecas gave less than three ounces; Fresnillo, one ounce. Such was the average yield. One hundred millions of ore had to be dug out of the earth to yield that sum. This fact will give some idea of the number of hands, the quantity of tools and animals required in mining. The Valenciana mine employs 3,100 laborers, not counting thousands employed in connection therewith. At Fresnillo 3,400 were employed at one time, and many of them supported large families.

About the middle of the 17th century the yield of silver was 500,000 marks; in 1630, 601,065 marks were coined; and in 1700, the coinage was only 397,543 marks. The duties on silver at that time amounted to 26 per cent.; they have since been lessened, though not sufficiently, in our opinion.

In 1720 the coinage was $12,000,000. The value of quicksilver was then $62 a quintal, and its consumption amounted to 42,618 quintals. In 1776 the price of quicksilver came down to $41, and the yield of silver was increased thereby. The college of mines was organized that same year, and mining was relieved from many taxes. In 1802 the coinage was $27,000,000, the largest ever reached. In 1712 the revenue from mines was $3,068,410; in 1764, it was $6,000,000; and in 1792, $19,000,000.

Nearly all our old mines are vast heaps of earth and ore thrown out, as too poor to be worked. Now, if this rubbish were washed, levigated, and amalgamated, much silver would be obtained by little labor. As much as 14 ounces per 20 quintals have been obtained from this refuse; and this yield would give a profit if no taxes were paid on it.

Silver is very unequally distributed in lodes; a vein is often broken by poor ore that will hardly pay, and miners must work on unpaid till they reach a lode that will enrich many families. To encourage this constant labor, all taxes upon mining must be removed. If this is done, many new mines would be opened and old ones would be worked with a prospect of a future profit.

The increase in the produce of the precious metals would be nothing compared to the impulse that mining would give to agriculture, manufactures, and commerce. The public revenue would be amply compensated for the supposed loss sustained by abolishing mining taxes. Trinidad Garcia, deputy from Zacatecas, gives the following data of the Fresnillo mines when worked by Proaño: from 1860 to 1863, $481,221 taxes were paid on the profits of those mines, amounting to over $120,000 a year. From 1866 to 1867, only $37,119 were paid in taxes on the same mines. Thus the government has suffered an annual loss of $83,185 for

not encouraging Mr. Proaño's enterprise. From 1853 to 1862, the yield of those mines was near $10,000,000, making more than $1,000,000 per year, and more than one-fourth of the national coinage. Fresnillo then had a population of 17,000; it now has scarcely 5,000.

So convinced of these facts was Mr. Auza, governor of Zacatecas, that he advised congress to relieve Mr. Proaño of all taxes upon his enterprise, and give him as a loan for five years all the profits of the mine above $37,000, the amount of taxes collected on the mine during the last fiscal year.

As we have shown that mining lends such influence to all other pursuits, it is evident that its encouragement would tend to promote universal industry and peace. What sources of prosperity for our unfortunate country!

As it is seen, we do not consider mining as advantageous to Mexico from the nature and quality of its products, which are the precious metals; nor do we commit the vulgar error of giving to these metals a value more tangible than that of other kinds of salable effects; but we see in mining an exhaustless source of industry, and in the precious metals an article of trade that has the advantage over all other articles, from its facility of transportation over bad roads and its small bulk compared to its value. One thousand ounces of gold are worth in this capital about 8,000 arrobas of sugar, and they can be carried to Vera Cruz for three or four dollars, while the sugar would cost from twelve to twenty thousand dollars, over the same roads. The ratio of freight, then, is 1 to 4,000. We have taken for comparison one of the most important of our agricultural products, but it does not belong to the region of the central tablelands, the most densely populated part of our country. What can be sent out of those regions except gold and silver? Cotton went up to such a price during the civil war in the United States that it could be profitably exported; but now it needs a protective tariff to enable it to compete with foreign cotton. If the precious metals then have no limit to their production, why are so many obstacles placed in the way of their production and exportation? What we have said relates to mining in connection with other national industries and internal commerce; but it is evident that foreign commerce or importation is also much influenced by it.

In his work on the foreign commerce of Mexico, Mr. Lerdo de Tejada has shown that more than four-fifths of the duties on exports were levied on the precious metals; the other duties were upon produce of the coast region, such as cochineal, vanilla, tobacco, dyewoods, and other articles of less importance. As the export duty on the precious metals is very high, much gold and silver is smuggled out of the country without paying export duty. The time is now come when we should shake off the old prejudices against foreign commerce, and encourage it rather than oppose it. To do this, and foster all other arts in this country, we ought to let the precious metals go out free without any tax.

We will not pretend to combat the common prejudice against the free export of gold and silver in bars or in coin, for political economy has already demonstrated that those metals do not differ in any respect from the other products of the soil. If there is a surplus of metal it must go out in exchange for necessaries for home consumption; but we will insist that if the precious metals are the only products of the country that have no limit, and that mining stimulates agriculture, manufacture and commerce, no obstacle should be placed in the way of its production, for by so doing all other branches of industry suffer as well as the public treasury.

We will now proceed to show that silver has to pay 24 per cent. of its net value on exportation, and all of this falls upon the miner. If the miner were allowed the free use of the metals which he produces, and were not compelled to coin them, nor prohibited from exporting them, he could sell his mark of pure silver at \$9 41½, its intrinsic value.

Now let us see what really becomes of 1,000 marks produced by him by the present system of taxes. We will suppose this silver to be pure, of the maximum fineness—that is, 12 dineros. The miner takes this sum to the assay office, where he has to pay a total of 6¼ per cent., making \$562 50 before he gets it back. Then he takes it to the mint, where the coinage will cost him \$415 36 more. But this is not all; neither the weight nor the fineness of the coins which the miner receives corresponds with the sum he is said to receive; for a diminution is not only permitted but advised by the ordinances of 1728, chapter 9. The diminution allowed is three-thousandths; that is, if the alloy should be 902.778 parts of pure silver, and 97.222 of copper, corresponding to 10 dineros 20 granos, the actual alloy is 899.78 of silver and 100.22 of copper; and this loss, too, falls upon the miner.

To simplify the calculation, we have supposed the silver to be pure—that is, of 12 dineros; but there is another loss in assaying which we have not mentioned. Improvements in docimacy have shown that the precious metals suffer two kinds of losses in cupelation: one is from the absorbtion of the metal by the crucible, and the other is its vaporization by heat, or, more properly speaking, the vapor of the oxide of lead which comes from the crucible carries off a portion of the melted metal with it mechanically. So that is another cause of loss to the miner.

And here is another source of loss: existing laws requires only halves of thousands to be marked in assaying. Thus, if the assay calls for 997¼, or ⅛, it is marked at 997, because it is less than one-half. This loss, added to that by fire just mentioned, was so considerable that it attracted the attention of Mr. Elhuyar at the beginning of this century. At that time the only mint of Mexico was in the capital.

The loss to the miner is still greater when silver is mixed with gold and has to be separated, but we will not treat of this at present, as we must confine ourselves to silver.

We think we have now demonstrated that the miner alone bears the

cost of coining, and it is the duty of the committee on mints to propose a remedy for this injustice to our most worthy producers.

We will now go back to our miner with his 1,000 marks of coined silver, which we will suppose he wishes to take to a port. His whole sum amounts to $9,415 36, and he has already paid on it $1,024 45, leaving $8,391 01. On this he has yet to pay a circulation tax of 2½ per cent., making $209 78. So he reaches the port with $8,181 23. On this again he has to pay an export duty of 7½ per cent., making $613 59. That leaves him with $7,567 64 for exportation. State taxes reduce this to $7,551 91. After all these reductions the miner finds he has lost 24.66 per cent. of the original amount, and his mark is reduced to $7 55, causing him to lose $1 86 on each mark, originally $9 41.

I will here anticipate an objection to this calculation, which is that the miner is not always the exporter of his silver. No matter; he will still have to lose the 24.66 per cent. in getting rid of it. If, for instance, he bought 20 yards of linen with his mark in bar, if he had it coined he could only buy 15 yards; for the merchant, without knowing it, would make that discount.

These exorbitant taxes make it worse for the miner than it was at the beginning of the 18th century, when the whole duty was only 26 per cent.

Some persons fear that if a free export of the precious metals were allowed, not enough would be left in the country for its commerce. Now money is like any other merchandise; its supply will depend upon the demand in the public markets. Exchange is the price of freight on money, and it will go where it is wanted. Trying to prevent the export of the precious metals, as the government has sometimes done, always causes harm to the community.

A compensation for the free export of gold and silver would be compensated in many ways. Free export of silver would increase the imports at least to the value of the metal sent out, and the duties on the goods imported would amount to more than the taxes on the silver exported.

Our custom-house returns of last year show that the revenue from imports amounted to 70 per cent., while the export tax on the precious metals only amounted to 26.66 per cent., as I have stated. Thus the national treasury would gain by the reverse system of the present.

This expected increase of export of the precious metals is not fancy, but is founded on the fact that there are large quantities of poor surface ores that would pay for reducing, and thus give time and means for more important enterprises. Much labor might be required in this work, but it would give employment to more persons and would increase the consumption of agricultural products.

Now, if the board has paid due attention to our report, it will be assured, as we are, that the wealth, prosperity, and peace of our country hang on this administrative maxim: Give every protection to miners.

With these remarks we submit to the board the following proposal:

Let the committee on mining propose to the minister of finance, as the only way to elevate rapidly that industry to the degree of prosperity which it is susceptible, the absolute exemption of gold and silver from all duties whatever.

Signed by Miguel Velazquez de Leon, Antonio del Castillo, Ignacio Rule. Mexico, May 25, 1868.

MR. CASTILLO ON THE ABOLITION OF THE EXPORT DUTIES ON THE PRECIOUS METAS.

A writer in the "Opinion Nacional" having argued that by relieving mining from the old taxes, by which 25 per cent. in value of the products were paid to the government, the public treasury would suffer a loss of $1,250,000 annually, Mr. Castillo replies by a letter, from which the following extracts are taken.[1]

Mr. Castillo is sure that the treasury will not suffer by the removal of this great tax; on the contrary, its removal will benefit the public treasury by acting as a stimulus to all kinds of industry. He says:

"It is evident that the export of the ores of gold and silver will tend to promote their production, which will encourage other industries beneficial to every country. The wealth of our mines does not depend upon the richness, but upon the abundance of the ore, as we see in the Rosario mine at Pachuca, where the ore only pays 12 ounces of silver to three quintals, (15 marks to 30 quintals, as the average,) or $1 per arroba.

"This being so, could the Real del Monte send its ores to Vera Cruz, and thence to Europe, with a profit, when the cost of land transportation is $1 per arroba, which is more than the ore is worth? It is absurd to think of it. This reasoning is equally applicable to mines far in the interior.

"Neither is there danger of diminution in the yield of mines near the sea coast, for it certainly would not pay to have the ore smelted abroad.

"The lessees of the mints must have originated this opposition to the free export of ores and metals in bars, for fear of losing the profits allowed them by the government for coining, as well as the other advantages not generally known.

"This act of Congress allowing the free export of the precious metals in every form has increased the non-productive mineral wealth of our country. There are certain ores of gold and silver on our Pacific coast that have resisted our simple method of reduction and amalgamation, and they will ever remain useless to us, unless we encourage the introduction of the more perfect methods of reduction used in Europe, or allow these ores a free exit. Their usual yield is one mark of silver to three quintals of ore; and as they contain a small quantity of gold, and often of lead and antimony, they might pay for exporting. The working of such mines would occupy an immense number of hands now unemployed. These miners would consume the land produce, and use the goods brought in

[1] El Siglio, XIX: Mexico, November 21, 1868.

by commerce; new roads would be opened, and new modes of transportation by rivers would be effected; all to the great advantage of the country.

"The prosperity of Mexico depends upon the prosperity of the mines, which encourage agriculture and stimulate foreign and domestic commerce.

"The only question to solve, for the encouragement of mining, is embraced in the principle of political economy: *Liberty to mining industry.*"

CALIFORNIA.

TREASURE EXPORTS.

According to the commercial statistics of the first three-quarters of the year 1868,[1] the total exports of gold bars, silver bars, and gold coin, for the first nine months of 1868 were as follows:

Gold bars	$14,762,912
Silver bars	8,243,718
Gold coin	1,572,268
Total	24,582,634

The total includes $3,735 of foreign gold coin, $1,500 Mexican dollars, $5,000 of silver, and $6,135 of dust. The amount and destination of the exports, compared with the like period in 1867, are as follows:

To—	1867.	1868.
China	$7, 153, 465 07	$3, 978, 009 65
Chili	723, 450 97	....
Central American ports	531, 044 55	533, 200 00
England	4, 426, 431 31	4, 639, 459 90
France	1, 453, 659 76	941, 553 47
Japan	53, 969 18	352, 459 46
Mexico	26, 000 00	8, 000 00
New York	17, 311, 315 77	18, 460, 421 30
Sandwich islands	8, 300 00	50, 000 00
Society islands	500 00	....
Vancouver island	50, 000 00	95, 000 00
Total	31, 738, 136 61	29, 058, 103 78
Add duties	5, 993, 704 00	6, 560, 729 95
	37, 731, 840 61	35, 618, 833 73
Decrease 1868	....	2, 113, 006 88

[1] Published in the Alta California newspaper, San Francisco, October 14, 1868. This paper, the Commercial Review, and other journals on the Pacific coast, devote great attention and care to the collection and publication, at regular intervals, of valuable commercial and mining statistics, without which very little would be known of the production and movement of the precious metals in the United States.

RECEIPTS OF TREASURE.

The receipts of treasure from the interior of California, including the bullion from the State of Nevada, were as follows, the receipts for the period of nine months in 1867 and 1868 being compared:

Mines.	1867.			1868.		
	Uncoined.	Coined.	Total.	Uncoined.	Coined.	Total.
Northern	$29,528,876	$2,444,998	$31,973,874	$27,362,923	$3,199,111	$30,562,034
Southern	2,328,834	959,519	3,288,353	2,220,639	1,236,080	3,456,719
Total	31,857,710	3,404,517	35,262,227	29,583,562	4,435,191	34,018,753
Decrease 1868						1,243,474

RECAPITULATION.

Sources.	1867.	1868.
Imports	$1,665,306	$1,636,636
Coastwise receipts	4,479,556	2,414,416
Interior	35,262,227	34,018,753
Total	41,407,089	38,069,805
Decrease 1868		3,337,284

The receipts from coastwise ports and Victoria (V. I.) for the period in the two years, 1867 and 1868, were:

Condition.	1867.	1868.
Uncoined	$4,150,340	$1,735,654
Coined	329,216	678,762
Total	4,479,556	2,414,416
Decrease 1868		2,065,140

The imports of treasure (exclusive of those from Victoria, which are included in the receipts from coastwise ports) for the nine months ending September 30, 1867 and 1868, respectively, were as follows:

Country.	1867.	1868.
Japan		$4,164 00
Mexico	$1,565,113 53	1,627,271 50
Panama	67,244 25	800 00
Sandwich Islands	30,447 91	4,400 00
Society Islands	2,500 00	
Total	1,665,305 69	1,636,635 50
Decrease 1868		28,670 19

PRODUCTION OF GOLD UP TO APRIL, 1851.

According to an estimate given in the San Francisco Herald, and quoted in the London Times, May 19, 1851, the production of gold in the

ate from the 1st of April, 1849, to the 31st of December, 1850, was 38,587,591. The custom-house records for this period, it will be rememred, were burned, and these figures thus have a peculiar value.

From the 1st of January to the 31st March, 1851, the first quarter, it stated that the shipments were:

Date.	In hands of passengers.	Consigned.
January	$1.042,000	$2,929,868
February	706,890	2,278,925
March	702,800	3,028,631
	2,451,600	8,237,542
Adding amount in hands of passengers		2,451,600
		10,689,142
s estimated that for the same period gold was sent overland to the amount of	$1,000,000	
ipped by merchants	450,000	
miners', merchants', and brokers' hands	1,000,000	
jewelery and stamped bullion	1,517,000	
		3,967,000
Total		$14,656,142

The value in the above estimates was computed at $16 per ounce troy, t the mint value was $1 60 more. By adding this, the estimated iount for the first quarter of 1851 is carried to over $16,000,000.

NEVADA.

During the summer of 1868, remarkably rich deposits of silver ore have in found in the White Pine district, about 120 miles easterly from istin. Large masses, consisting chiefly of chloride of silver, have been ten out, and it is expected that the region will soon produce large ounts of silver.

BORNEO.

The exports of gold from the port of Sarawak, Borneo, for five years ling in 1867, were as follows, according to the British consular returns 1868:

33	$5,220
34	9,480
35	5,394
36	2,250
37	6,998

APPENDIX B.

RELATIVE VALUES OF GOLD AND SILVER.

From statements by Pliny it appears that in the Roman coins the value of gold to silver was as 5,760 to 336, or as $17\frac{1}{7}$ to 1; but this was not the relative value in bullion, which appears to have been as $14\frac{13}{28}$ to 1. This ratio did not long continue. About 189 B. C. the Romans coincided with the Greeks in estimating the value of gold compared with silver as 10 to 1.

Upon Cæser's return to Rome with the spoils of war, gold became so abundant that its value, compared with silver, fell to the ratio of 750 to 100, or $7\frac{1}{2}$ to 1. This, however, was a transient depression in the value of gold, for, in the time of Claudius, about a century later, the value of gold had advanced so that its ratio to silver became as $12\frac{1}{2}$ to 1. This ratio appears to have been preserved through the reigns of Nero and Galba, and during the interval between Galba and Alexander Severus, or more than 150 years.

Under Constantine the Great the value of gold had receded, as compared with silver, to the ratio of $10\frac{1}{2}$ to 1; but 60 years after Constantine the value had increased to $14\frac{2}{5}$ to 1.

In a statement by Herodotus of the revenues of Darius, the son of Hystaspes, he proceeds upon the supposition that the value of gold to silver was as 13 to 1. It is supposed that the value of gold did not long continue to be so high in Greece, for Plato, 50 years after Herodotus, asserted the ratio to be as 12 to 1. Gold had at that time a lower value in Persia than in Greece. The ratio in Persia appears to have been as $11\frac{2}{3}$ to 1.

Gold afterwards became so plentiful in Greece that its value was estimated, compared with silver, as 10 to 1. This was about 341 years B. C. It is supposed that the value of gold, compared with silver, continued to be as 10 to 1 for 170 years after the death of Alexander.

When guineas were first coined in 1663 the value of fine gold, compared with that of fine silver, was rated in the English mint at $14\frac{221}{682}$ to 1. Guineas were then coined as 20 shilling pieces, but were afterwards made current as 21 shilling pieces. In 1805 the relative value of fine gold to fine silver was as $15\frac{2859}{13640}$ to 1, and in mints of several other countries it was rated still higher.[1]

---

[1] *Vide* "A Treatise on the Coins of the Realm," in a letter to the King. By Charles, Earl of Liverpool: Oxford, 1805. 4to.

wing tabular statements show the ratio or value of gold to fferent periods down to the present time:

E VALUES OF GOLD AND SILVER AT DIFFERENT PERIODS.

Period.	Gold.		Silver.
—41st year	$9\frac{51}{191}$	to	1
I.—18th year, commencement of gold coinage.	$12\frac{14844}{25403}$	to	1
I.—18th year, July 9	$11\frac{1175}{25403}$	to	1
I.—20th year	$11\frac{1637}{72865}$	to	1
I.—27th year	$11\frac{151}{955}$	to	1
—13th year, silver coin debased	$10\frac{190}{573}$	to	1
7.—4th year	$11\frac{151}{955}$	to	1
I	$11\frac{59}{220}$	to	1
(old standard)	$10\frac{5614}{5921}$	to	1
(new standard)	$10\frac{617}{682}$	to	1
2d and 3d years, (old standard)	$12\frac{876}{5921}$	to	1
2d and 3d years, (new standard)	$12\frac{186}{1703}$	to	1
9th year	$13\frac{10739}{29063}$	to	1
9th year	$13\frac{248}{775}$	to	1
17th year	$13\frac{2059}{5921}$	to	1
17th year	$13\frac{118}{341}$	to	1

Merchants' Magazine for August, 1863, contains the following h covers a portion of the period given above, and shows the lue of gold to silver at various periods from 1344 to 1863, as by the prices paid by the mint in London:

	12.475 to 1	1547	11.400 to 1
	11.141 to 1	1549	11.250 to 1
	11.286 to 1	1552	11.186 to 1
	11.350 to 1	1553	11.198 to 1
	10.527 to 1	1560	11.315 to 1
	10.331 to 1	1600	11.100 to 1
	11.983 to 1	1604	12.109 to 1
	11.446 to 1	1626	13.431 to 1
	11.429 to 1	1666	14.485 to 1
	11.400 to 1	1717	15.209 to 1
	11.455 to 1	1816	15.209 to 1
	12.000 to 1	1849	15.632 to 1
	10.714 to 1	1852	15.371 to 1
	10.000 to 1	1863	15.069 to 1

. Elliott, of Washington city, has kindly furnished the following on this interesting subject to Commissioner Browne. The abular statement has been prepared by him with great care, s in some respects from that of the Merchants' Magazine:

Ratios of the market value of gold to silver, in London, for the 70 *years from* 1760 *to* 1829, *inclusive, and the* 26 *years from* 1841 *to* 1866, *inclusive—in all,* 96 *years.*

1760 to 1789	(30 years)	14.50 to 1	Prior to the opening of the gold mines of California and Australia.
1790 to 1809	(20 years)	14.90 to 1	
1810 to 1819	(10 years)	15.50 to 1	
1820 to 1829	(10 years)	15.80 to 1	
1830 to 1840	(11 years)	....	
1841 to 1848	(8 years)	15.83 to 1	
Discovery of gold fields in California, 1848.			
1849 to 1852	(4 years)	15.60 to 1	—Transition period.
1853 to 1858	(6 years)	15.34 to 1	Since the opening of California and Australian gold fields, average 15.38 to 1.
1859 to 1862	(4 years)	15.34 to 1	
1863 to 1864	(2 years)	15.37 to 1	
1865 to 1866	(2 years)	15.46 to 1	

Simplest, and probably most convenient, mint ratio of gold to silver, 15 to 1; present United States mint ratio of gold to fractional silver, 14.88 to 1; United States mint ratio of gold to silver dollar, (circulation limited because overvalued,) 16 to 1; British mint ratio of gold to silver, 14.28 to 1; French mint ratio of gold to silver 5-franc piece, (circulation limited because undervalued,) 15.5 to 1; French mint ratio, gold to debased smaller silver coinage, 14.38 to 1.

The ratios since 1859 were deduced from the semi-monthly quotations of the price per ounce of silver bars in London, published from time to time in the journal of the Statistical Society of London. From 1841 to 1848 the values adopted were computed from data furnished by Mr. William Newmarch in a valuable paper read by him before the London Statistical Society and published in the journal of that society. From 1760 to 1829, inclusive, the values were taken from the funding system of Mr. Jonathan Elliott, which forms part of the executive documents of the second session of the 28th Congress. For the 11 years, 1830 to 1840, inclusive, there is a lapse in the information furnished; but it is deemed safe to assume the ratio for this period as 15.8, the ratio of the periods just prior and subsequent to the interval.

It will be observed that with the discovery and working of the California and Australian gold fields the relative value of gold to silver fell from an average of $15\frac{7}{8}$ for the eight years 1841–'48, just prior to this event, to an average of $15\frac{3}{8}$ for the 14 years 1853–'66, which followed the transition period of four years 1849–'52.

APPENDIX C.

RULES FOR CALCULATION OF ALLOYS AND VALUES.

RULES FOR THE PREPARATION OF ALLOYS OF A GIVEN FINENESS.

Manufacturers of silverware may obtain an alloy of silver of any desired fineness in melting fine silver with silver of an inferior quality by observing the following rule:[1]

Obtain the difference between the two higher finenesses, and divide by the difference between the two lower; the quotient indicates the number of ounces of the silver to be raised in fineness, which are required to be added to one ounce of fine silver.

Example.—Required to raise a quantity of silver of the fineness of $\frac{867}{1000}$ to $\frac{900}{1000}$ by the mixture with it of fine silver at $\frac{999}{1000}$.

Difference between the two higher finenesses $\frac{99}{1000}$. Difference between the two lower finenesses $\frac{33}{1000}$. $99 \div 33 = 3$. From this it appears that one ounce of fine silver at $\frac{999}{1000}$ will raise the fineness of three ounces of silver at $\frac{867}{1000}$, so that the compound will consist of four ounces at $\frac{900}{1000}$.

MODE OF VALUATION.

According to law, the standard gold of the United States consists in 1000 parts by weight, of 900 of pure gold and 100 of an alloy composed of copper and silver.

Three hundred and eighty-seven ounces of pure gold are worth $8,000, and 99 ounces of pure silver are worth $128. These relations furnish the following proportions, from which are readily derived the subjoined rules:

For gold.—As $1000 : \frac{8000}{387}$, or as 99,000 : 128 :: the given weight multiplied by its particular fineness in thousandths : the value of said weight.

For silver.—As $1000 : \frac{128}{99}$, or as 387 : 8 :: the given weight multiplied by its particular fineness in thousandths : the value of said weight.

RULES.

To find the value in United States money of any number of troy ounces of gold or silver, the weight and fineness being given:

For gold.—Multiply the given weight by the fineness and by 8, and divide the product by 387.

For silver.—Multiply the given weight by the fineness and by 128, and divide the product by 99,000.

[1] This and the following rules are extracted by special permission from the "Bullion Dealers' Guide," by George W. Edelman, which contains many valuable tables useful to dealers in the precious metals.

SHORT METHODS OF CALCULATION.

FOR GOLD.

1. TO CONVERT WEIGHT INTO VALUE.

Multiply the weight by double the fineness, add to the produ thereof, plus $\frac{1}{129}$ of the $\frac{1}{30}$, the answer will be in cents.

Example.—What is the value of 1,258 ounces at 774 thousandths

$$
\begin{array}{lr}
1258 \times 1548 = & 19473.84 \\
\frac{1}{30} & 649.128 \\
\frac{1}{129} & 5.032 \\
\hline
\textit{Answer:} & \$20{,}128.00
\end{array}
$$

By this rule the value of one ounce of gold, of any fineness, ma readily determined.

Example.—What is the value of 1 ounce at 658½ thousandths?

$$
\begin{array}{lr}
658\frac{1}{2} \times 2 = & 1317. \\
\frac{1}{30} & 43.9 \\
\frac{1}{129} & .34 \\
\hline
\textit{Answer:} & \$13.6124
\end{array}
$$

The division by 129 being somewhat difficult, it will be found ciently accurate, in most cases, to divide by 130.

2. TO CONVERT VALUE INTO STANDARD WEIGHT.

Divide the value in dollars by 20, this quotient by 20, and the se quotient by 2, add the three quotients together; the answer will standard ounces.

Example.—What is the weight in standard ounces of $154,686 56

$$
\begin{array}{rr}
20) & 154686.56 \\
\hline
20) & 7734.328 \\
2) & 386.7164 \\
 & 193.3582 \\
\hline
\textit{Answer:} & 8314.4026 \text{ ounces.}
\end{array}
$$

FOR SILVER.

1. TO CONVERT WEIGHT INTO DOLLAR VALUE.

Add to the weight in standard ounces $\frac{1}{11}$ thereof, plus the $\frac{8}{10}$ of the the answer will be in dollars.

Example.—What is the value of 1268.30 standard ounces?

$$
\begin{array}{rr}
 & 1268.30 \\
\frac{1}{11} & 115.30 \\
\frac{8}{10} \text{ of } \frac{1}{11} & 92.24 \\
\hline
\textit{Answer:} & \$1475.84
\end{array}
$$

2. TO CONVERT DOLLAR VALUE INTO STANDARD OUNCES.

Subtract from the value $\frac{1}{8}$ thereof, plus $\frac{1}{8}$ of this quotient; the answer will be in standard ounces.

Example.—What is the weight of $1475 84?

	$1475.84
$\frac{1}{8}$	184.48
$\frac{1}{8}$	23.06
	207.54
Answer:	1268.30 standard ounces.

APPENDIX D.

TABLES OF DEPOSITS, COINAGE, EXPORTATION, AND PRODUCTION OF THE PRECIOUS METALS.

TABLE I.—DEPOSITS OF GOLD AND SILVER.

Statement of deposits of gold and silver at the mint of the United States, the branch mint, San Francisco, assay office, New York, and branch mint, Denver, during the fiscal year ending June 30, 1868.[1]

Description of bullion.	United States mint, Philadelphia.	Branch mint, San Francisco.	Assay office, New York.	Branch mint, Denver.	Total.
GOLD.					
Fine bars	$2,142,337 12	$8,693,399 01			$10,835,736 13
Unparted bars					
United States bullion	1,300,338 53	6,156,718 83	$5,409,996 55	$357,935 11	13,224,989 02
United States coin	95,452 90		54,074 20		149,527 10
Jewellers' bars	157,418 38		269,598 30		427,016 68
Foreign coin	14,789 73	73,098 15	25,127 27		113,015 15
Foreign bullion	332,711 97	56,342 53	333,556 24		722,610 74
Total gold	4,043,048 63	14,979,558 52	6,092,352 56	357,935 11	25,472,894 82
SILVER.					
Bars	$219,727 08	$397,341 00			$617,068 08
United States bullion	67,700 78	256,898 05	$262,312 96	$5,082 67	591,994 46
United States coin	7,587 81		99,935 77		107,523 58
Jewellers' bars	26,520 77		85,807 05		112,327 82
Foreign coin	17,907 72	53,671 87	142,215 87		213,795 46
Foreign bullion	3,191 56	8,956 74	41,566 18		53,714 48
Total silver	342,635 72	713,867 66	631,837 83	5,082 67	1,693,423 88
Total gold and silver	$4,385,684 35	$15,693,426 18	$6,724,190 39	$363,017 78	$27,166,319 73
Less re-deposits at different institutions: gold, $2,355,128 38; silver, $219,864 48					2,574,992 86
Total deposits					$24,591,325 84

[1] From the annual report of the director of the United States mint.

Statement of the coinage at the mint of the United States, the branch mint, San Francisco, assay office, New York, and branch mint, Denver, during the fiscal year ending June 30, 1868.[1]

Denomination.	United States mint, Philadelphia.		Branch mint, San Francisco.		Assay office, New York.	Branch mint, Denver.	Total.	
	Pieces.	Value.	Pieces.	Value.	Value.	Value.	Pieces.	Value.
GOLD.								
Double eagles	188, 540	$3, 770, 800 00	696, 750	$13, 935, 000			885, 290	$17, 705, 800 00
Eagles	3, 050	30, 500 00	12, 500	125, 000			15, 550	155, 500 00
Half eagles	5, 750	28, 750 00	25, 000	125, 000			30, 750	153, 750 00
Three dollars	4, 900	14, 700 00					4, 900	14, 700 00
Quarter eagles	3, 650	9, 125 00	26, 000	65, 000			29, 650	74, 125 00
Dollars	10, 550	10, 550 00					10, 550	10, 550 00
Fine bars	151	98, 843 03			$5, 567, 082 77			5, 665, 930 80
Unparted bars						$360, 879 26		360, 879 26
Total gold	216, 591	3, 963, 273 03	760, 250	14, 250, 000	5, 567, 082 77	360, 879 26	976, 690	24, 141, 235 06
SILVER.								
Dollars	54, 800	54, 800 00					54, 800	54, 800 00
Half dollars	411, 500	205, 750 00	1, 482, 000	741, 000			1, 893, 500	946, 750 00
Quarter dollars	29, 900	7, 475 00	120, 000	30, 000			149, 900	37, 475 00
Dimes	423, 150	42, 315 00	310, 000	31, 000			733, 150	73, 315 00
Half dimes	85, 800	4, 290 00	400, 000	20, 000			485, 800	24, 290 00
Three-cent pieces	4, 000	120 00					4, 000	120 00
Bars	83	6, 729 94			449, 506 54			456, 236 48
Total silver	1, 009, 233	321, 479 94	2, 312, 000	822, 000	449, 506 54		3, 321, 150	1, 592, 986 48

[1] From the Report of the Director of the United States Mint.

TABLE II—Continued.

Denomination.	United States mint, Philadelphia.		Branch mint, San Francisco.		Assay office, New York.	Branch mint, Denver.	Total.	
	Pieces.	Value.	Pieces.	Value.	Value.	Value.	Pieces.	Value.
COPPER.								
Five-cent pieces	28, 902, 000	1, 445, 100 00					28, 902, 000	1, 445, 100 00
Three-cent pieces	3, 613, 000	$108, 390 00					3, 613, 000	$108, 390 00
Two-cent pieces	3, 066, 500	61, 330 00					3, 066, 500	61, 330 00
One-cent pieces	9, 856, 500	98, 565 00					9, 856, 500	98, 565 00
Total copper	45, 438, 000	1, 713, 385					45, 438, 000	1, 713 385 00
Total coinage	46, 663, 874	$5, 998, 137 94	3, 072, 250	$15, 072, 000	$6, 016, 589 31	$360, 879 26	49, 735, 840	$27, 447, 606 54

Summary exhibit of the entire deposits of domestic gold at the mint of the United States and branches to June 30, 1868.

Mint.	Parted from silver.	Virginia.	N. Carolina.	S. Carolina.	Georgia.	Alabama.	Tennessee.	Utah Territory.	Nebraska.	Colorado Territory.	California.
Philadelphia	$113,399 08	$1,567,910 19	$4,666,026 38	$542,667 26	$2,541,409 38	$55,697 19	$36,403 88	$4,397 11	$5,876 08	$5,990,560 93	$230,961,430 12
San Francisco	3,262,716 03	....	....	....	....	....	....	....	....	60,152 00	205,857,784 00
New Orleans	....	....	741 00	16,217 00	41,241 00	77,943 53	2,883 12	....	....	3,437 20	22,965,240 89
Charlotte	....	....	4,520,730 79	460,523 34	....	....	....	....	....	....	87,321 01
Dahlonega	....	....	99,585 19	311,242 81	4,310,459 61	59,629 92	42,119 75	145 14	....	35,345 84	1,136,016 69
N. Y. assay office	432,189 40	23,683 92	147,755 95	25,821 03	159,894 64	9,124 62	273 64	83,197 30	....	7,017,720 04	144,372,812 38
Denver	....	....	....	....	....	....	....	....	....	1,426,056 18	....
Total	3,808,844 51	1,591,594 11	9,434,839 31	1,356,471 44	7,053,004 63	202,325 26	81,680 39	87,669 55	5,876 08	14,463,272 19	604,680,605 09

Mint.	Montana Territory.	Arizona Territory.	New Mexico Territory.	Oregon.	Nevada.	Washington Territory.	Dakota Territory.	Vermont.	Idaho Territory.	Other sources.	Total.
Philadelphia	$4,976,001 78	$7,883 29	$74,083 47	$184,474 19	$3,383 64	$26,127 56	$2,198 88	....	$2,889,594 98	$44,515 50	$254,694,440 88
San Francisco	1,397,190 76	151,858 29	....	9,303,075 99	159,238 93	35,132 94	5,760 00	....	10,625,727 29	19,672,293 90	250,530,930 13
New Orleans	....	....	....	....	....	....	....	....	....	7,290 00	22,414,993 74
Charlotte	....	....	....	....	....	....	....	....	....	....	5,068,575 14
Dahlonega	....	....	....	....	....	....	....	....	....	951 00	5,995,495 95
N. Y. assay office	10,684,054 58	23,618 25	48,676 51	56,479 46	47,917 36	....	....	$1,512 66	556,255 81	644,125 00	164,335,112 55
Denver	151,506 06	339 48	....	8,073 05	....	....	....	....	91,391 99	....	1,677,366 76
Total	17,208,753 18	183,699 31	122,759 98	9,552,102 69	210,539 93	61,260 49	7,958 88	1,512 66	14,162,970 07	20,369,175 40	704,646,915 15

TABLE IV.—DEPOSITS AND COINAGE OF SILVER OF DOMESTIC PRODUCTION.

Statement of the amount of silver of domestic production deposited at the mint of the United States and branches from January, 1841, to June 30, 1868.

Year.	Parted from gold.	Oregon.	Arizona Territory.	Nevada.	Lake Superior.	Idaho Territory.	Georgia.	California.	Montana Territory.	N. Mexico Territory & Sonora.	North Carolina.	Colorado Territory.	Bars.	Total.
1841 to 1851	$768, 509 00	....	....	....	....	....	....	....	....	....	....	....	....	$768, 509 00
1852	404, 494 00	....	....	....	....	....	....	....	....	....	....	....	....	404, 494 00
1853	417, 297 00	....	....	....	....	....	....	....	....	....	....	....	....	417, 297 00
1854	328, 199 00	....	....	....	....	....	....	....	....	....	....	....	....	328, 199 00
1855	333, 053 00	....	....	....	....	....	....	....	....	....	....	....	....	333, 053 00
1856	321, 938 38	....	....	....	....	....	....	....	....	....	....	....	....	321, 938 38
1857	127, 256 12	....	....	....	....	....	....	....	....	....	....	....	....	127, 256 12
1858	300, 849 36	....	....	....	$15, 623 00	....	....	....	....	....	....	....	....	316, 472 36
1859	219, 647 34	....	....	....	30, 122 13	....	....	....	....	....	$23, 398 00	....	....	273, 167 47
1860	138, 561 70	....	$13, 357 00	$102, 540 57	25, 880 58	....	....	....	....	$1, 200 00	12, 257 00	....	....	293, 796 85
1861	364, 724 73	....	12, 260 00	213, 420 84	13, 372 72	....	....	....	....	....	6, 233 00	....	....	610, 011 29
1862	245, 122 47	....	105 00	757, 446 60	21, 366 38	....	....	$824 00	....	....	....	....	....	1, 024, 864 45
1863	188, 394 94	....	....	856, 043 27	13, 111 32	....	....	....	....	....	....	....	....	1, 057, 549 53
1864	166, 791 55	....	....	311, 837 01	8, 765 77	....	....	....	....	45 00	....	....	....	487, 439 33
1865	251, 757 87	....	....	355, 910 42	13, 671 51	....	....	459 18	....	25 84	....	....	....	621, 824 82
1866	271, 888 51	$1, 580 51	139 63	540, 345 87	22, 913 96	$38, 859 49	$403 83	453 00	....	....	....	$419 00	$16, 278 22	893, 282 02
1867	265, 932 64	183 68	3, 212 26	579, 931 76	18, 555 35	160, 269 24	....	310 25	$19, 095 48	....	(*)	543 78	10, 709 00	1, 058, 743 44
1868	147, 358 87	....	6, 711 29	290, 415 51	26, 595 72	37, 602 56	....	9, 196 94	23, 547 73	473 56	73 75	46, 881 13	397, 478 40	986, 335 46
Total	5, 261, 776 48	1, 764 19	35, 785 18	4, 007, 891 85	209, 978 44	236, 731 29	403 83	11, 243 37	42, 643 21	1, 744 40	41, 961 75	47, 843 91	424, 465 62	10, 324, 233 52

* Minnesota.

TABLE IV—Continued.

nt of silver coinage at mint of the United States and branches at n Francisco and New Orleans, under act of February 21, 1853.

Year.	United States mint, Philadelphia.	Branch mint, San Francisco.	Branch mint, N. Orleans, to Jan. 31, '61.	Total.
....	$7,806,461 00	....	$1,225,000 00	$9,031,461 00
....	5,340,130 00	....	3,246,000 00	8,586,130 00
....	1,393,170 00	$164,075 00	1,918,000 00	3,475,245 00
....	3,150,740 00	177,000 00	1,744,000 00	5,071,740 00
....	1,333,000 00	50,000 00	....	1,383,000 00
....	4,970,980 00	127,750 00	2,942,000 00	8,040,730 00
....	2,926,400 00	283,500 00	2,689,000 00	5,898,900 00
....	519,890 00	356,500 00	1,293,000 00	2,169,390 00
....	1,433,800 00	198,000 00	414,000 00	2,045,800 00
....	2,168,941 50	641,700 00	....	2,810,641 50
....	326,817 80	815,875 00	....	1,142,692 80
....	177,544 10	347,500 00	....	525,044 10
....	278,279 66	474,635 58	....	752,915 24
....	399,314 50	723,292 64	....	1,122,607 14
....	352,871 00	780,048 54	....	1,132,919 54
....	314,750 00	822,000 00	....	1,136,750 00
al....................	32,893,089 56	5,961,876 76	15,471,000 00	54,325,966 32

TABLE V.—TOTAL COINAGE OF THE UNITED STATES MINT.

Gold, silver, and copper coinage at the mint of the United States in the several years from its establishment in 1792; the coinage at the branch mints and the assay office, New York, from their organization to June 30, 1868.[1]

Years.	Gold.	Silver.	Copper.	Total.
1793 to 1795	$71,485 00	$370,683 80	$11,373 00	$453,541 80
1796	102,727 50	79,077 50	10,324 40	192,129 40
[illegible]	103,423 50	12,591 45	9,510 34	125,524 29
[illegible]	205,610 00	330,291 00	9,797 00	545,698 00
[illegible]	213,285 00	423,515 00	9,106 68	645,906 68
[illegible]	317,760 00	224,296 00	29,279 40	571,335 40
	1,014,290 00	1,440,454 75	79,390 82	2,534,135 57
1801	$422,570 00	$74,758 00	$13,628 37	$510,956 37
1802	423,310 00	58,343 00	34,422 83	516,075 83
1803	258,377 50	87,118 00	25,203 03	370,698 53
1804	258,642 50	100,340 50	12,844 94	371,827 94
1805	170,367 50	149,388 50	13,483 48	333,239 48
1806	324,505 00	471,319 00	5,260 00	801,084 00
1807	437,495 00	597,448 75	9,652 21	1,044,595 96
1808	284,665 00	684,300 00	13,090 00	982,055 00
1809	169,375 00	707,376 00	8,001 53	884,752 53
1810	501,435 00	638,773 50	15,660 00	1,155,868 50
	3,250,742 50	3,569,165 25	151,246 39	6,971,154 14
1811	$497,905 00	$608,340 00	$2,495 95	$1,108,740 95
1812	290,435 00	814,029 50	10,755 00	1,115,219 50
1813	477,140 00	620,951 50	4,180 00	1,102,271 50
1814	77,270 00	561,687 50	3,578 30	642,535 80
1815	3,175 00	17,308 00	....	20,483 00
1816	....	28,575 75	28,209 82	56,785 57
1817	....	607,783 50	39,484 00	647,267 50
1818	242,940 00	1,070,454 50	31,670 00	1,345,064 50
1819	258,615 00	1,140,000 00	26,710 00	1,425,325 00
1820	1,319,030 00	501,680 70	44,075 50	1,864,786 20
	3,166,510 00	5,970,810 95	191,158 57	9,328,479 52
1821	$189,325 00	$825,762 45	$3,890 00	$1,018,977 45
1822	88,980 00	805,806 50	20,723 39	915,509 89
1823	72,425 00	895,550 00	....	967,975 00
1824	93,200 00	1,752,477 00	12,620 00	1,858,297 00
1825	156,385 00	1,564,583 00	14,926 00	1,735,894 00
1826	92,245 00	2,002,090 00	16,344 25	3,110,679 25
1827	131,565 00	2,869,200 00	23,577 32	3,024,342 32
1828	140,145 00	1,575,600 00	25,636 24	1,741,381 24
1829	295,717 50	1,994,578 00	16,580 00	2,306,875 50
1830	643,105 00	2,495,400 00	17,115 00	3,155,620 00
	1,903,092 50	16,781,046 95	151,412 20	18,835,551 65

[1] From the report of the Secretary of the Treasury, 1868, pp. 448, 449.

l, silver, and copper coinage at the mint of the United States, &c.—Cont'd.

Years.	Gold.	Silver.	Copper.	Total.
....	$714, 270 00	$3, 175, 600 00	$33, 603 60	$3, 923, 473 60
....	798, 435 00	2, 579, 000 00	23, 620 00	3, 401, 065 00
....	978, 550 00	2, 759, 000 00	28, 160 00	3, 765, 710 00
....	3, 954, 270 00	3, 415, 002 00	19, 151 00	7, 388, 423 00
....	2, 186, 175 00	3, 443, 003 00	39, 489 00	5, 668, 667 00
....	4, 135, 700 00	3, 606, 100 00	23, 100 00	7, 764, 900 00
....	1, 148, 305 00	2, 096, 010 00	55, 583 00	3, 299, 898 00
....	1, 809, 595 00	2, 315, 250 00	63, 702 00	4, 188, 547 00
....	1, 375, 760 00	2, 098, 636 00	31, 286 61	3, 505, 682 00
....	1, 690, 802 00	1, 712, 178 00	24, 627 00	3, 427, 607 61
	18, 791, 862 00	27, 199, 779 00	342, 322 21	46, 333, 963 21
....	$1, 102, 107 50	$1, 115, 875 00	$15, 973 67	$2, 233, 957 17
....	1, 833, 170 50	2, 325, 750 00	23, 833 90	4, 182, 754 40
....	8, 302, 797 50	3, 722, 260 00	24, 283 20	12, 049, 330 70
....	5, 428, 230 00	2, 230, 550 00	23, 977 52	7, 687, 757 51
....	3, 756, 447 50	1, 873, 200 00	38, 948 04	5, 668, 595 54
....	4, 034, 176 57	2, 558, 580 00	41, 208 00	6, 633, 965 50
....	20, 221, 385 00	2, 374, 450 00	61, 836 69	22, 657, 671 60
....	3, 775, 512 50	2, 040, 050 00	64, 157 99	5, 879, 720 49
....	9, 007, 761 50	2, 114, 950 00	41, 984 32	11, 164, 695 82
....	31, 981, 738 50	1, 866, 100 00	44, 467 50	33, 392, 306 00
	89, 443, 328 00	22, 226, 755 00	380, 670 83	112, 050, 753 83
....	$62, 614, 492 50	$774, 397 00	$99, 635 43	$63, 488, 524 93
....	56, 846, 187 50	999, 410 00	50, 630 94	57, 896, 228 44
....	55, 213, 906 94	9, 077, 571 00	67, 059 78	64, 358, 537 72
....	52, 094, 595 47	8, 619, 270 00	42, 638 35	60, 756, 503 82
....	52, 795, 457 20	3, 501, 245 00	16, 030 79	56, 312, 732 99
....	59, 343, 365 35	5, 196, 670 17	27, 106 78	64, 567, 142 30
.1 to June 30, inclusive)	25, 183, 138 68	1, 601, 644 46	63, 510 46	26, 848, 293 60
year	52, 889, 800 29	8, 233, 287 77	234, 000 00	61, 357, 088 06
year	30, 409, 953 70	6, 833, 621 47	307, 000 00	37, 550, 585 17
year	23, 447, 283 35	3, 250, 636 26	342, 000 00	27, 039, 919 61
	470, 838, 180 98	48, 087, 763 13	1, 249, 612 53	520, 175, 556 64
....	$80, 708, 400 64	$2, 883, 706 94	$101, 660 00	$83, 693, 767 58
....	61, 676, 576 55	3, 231, 081 51	116, 000 00	65, 023, 658 06
....	22, 645, 729 90	1, 564, 297 22	478, 450 00	24, 688, 477 12
....	23, 982, 748 31	850, 086 99	463, 800 00	25, 296, 635 30
....	30, 685, 699 95	950, 218 69	1, 183, 330 00	32, 819, 248 64
....	37, 429, 430 46	1, 596, 646 58	646, 570 00	39, 672, 647 04
....	39, 838, 878 82	1, 562, 694 18	1, 879, 540 00	43, 281, 113 00
....	24, 141, 245 06	1, 592, 986 48	1, 713, 385 00	27, 447, 616 54
	$321, 108, 709 69	$14, 231, 718 59	$6, 582, 735 00	$341, 923, 157 28

Gold, si[illegible] copper coinage at the mint of the United States, &c.—Con'd.

RE[illegible]ITULATION OF COINAGE FROM 1793 TO 1868, INCLUSIVE.

Years.	Gold.	Silver.	Copper.	Total.
1793-1800, 8 years	$1,014,290 00	$1,440,454 75	$79,390 82	$2,534,135 57
1801-1810, 10 years	3,250,742 50	3,569,165 25	151,246 39	6,971,154 14
1811-1820, 10 years	3,166,510 00	5,970,810 95	191,158 57	9,328,479 32
1821-1830, 10 years	1,903,092 50	16,781,046 95	151,412 20	18,835,551 65
1831-1840, 10 years	18,791,862 00	27,199,779 00	342,322 21	46,333,963 21
1841-1850, 10 years	89,443,328 00	22,226,755 00	380,670 83	112,050,753 83
1851-1860, 9½ years	470,838,180 98	48,087,763 13	1,249,612 53	520,175,556 64
1861-1868, 8 years	321,108,709 69	14,231,718 59	6,582,735 60	341,923,163 28
Total 75 years	$909,516,715 67	$139,507,493 62	$9,128,548 55	$1,058,152,737 84

RECAPITULATION OF AVERAGES OF COINAGE FOR EACH DECADE FROM 1793 TO 1868, INCLUSIVE.

Years.	Gold.	Silver.	Copper.	Total.
1793-1800, 8 years	$126,786 25	$180,056 84	$9,923 85	$316,766 94
1801-1810, 10 years	325,074 25	356,916 52	15,124 64	697,115 41
1811-1820, 10 years	316,651 00	597,081 09	19,115 86	932,847 95
1821-1830, 10 years	190,309 25	1,678,104 69	15,141 22	1,883,555 16
1831-1840, 10 years	1,879,186 20	2,719,977 90	34,232 22	4,633,396 32
1841-1850, 10 years	8,944,332 80	2,222,675 50	38,067 08	11,205,075 38
1851-1860, 9½ years	49,561,913 79	5,061,869 80	131,538 16	54,755,321 75
1861-1868, 8 years	40,138,587 46	1,778,964 82	822,840 62	42,740,393 90

TABLE VI.—IMPORTS AND EXPORTS OF COIN.

tement exhibiting the imports and exports of coin and bullion from the United States from 1821 *to* 1868, *inclusive.*[1]

Years ended—	Imports.	Exports.		
		Domestic exports.	Foreign re-exports.	Total.
ember 30, 1821	$8,064,890		$10,478,059	$10,478,059
1822	3,369,846		10,810,180	10,810,180
1823	5,097,896		6,372,897	6,372,897
1824	8,379,835		7,014,552	7,014,552
1825	6,150,765		8,797,055	8,797,055
1826	6,880,966	$605,855	4,098,678	4,704,533
1827	8,151,130	1,043,574	6,971,306	8,014,880
1828	8,489,741	693,037	7,550,439	8,243,746
1829	7,403,612	612,886	4,311,134	4,924,020
1830	8,155,964	937,151	1,241,622	2,178,773
1831	7,305,945	2,058,474	6,956,457	9,014,931
1832	5,907,504	1,410,941	4,245,399	5,656,340
1833	7,070,368	366,842	2,244,859	2,611,701
1834	17,911,632	400,500	1,676,258	2,076,758
1835	13,131,447	729,601	5,748,174	6,477,775
1836	13,400,881	345,738	3,978,598	4,324,336
1837	10,516,414	1,283,519	4,692,730	5,976,249
1838	17,747,116	472,941	3,035,105	3,508,046
1839	5,595,176	1,908,358	6,868,385	8,776,743
1840	8,882,813	2,235,073	6,181,941	8,417,014
1841	4,988,633	2,746,486	7,287,846	10,034,332
1842	4,087,016	1,170,754	3,642,785	4,813,539
months to June 30, 1843	22,390,559	107,429	1,413,362	1,520,791
30, 1844	5,830,429	183,405	5,270,809	5,454,214
1845	4,070,242	844,446	7,762,049	8,606,495
1846	3,777,732	423,851	3,481,417	3,905,268
1847	24,121,289	62,620	1,844,404	1,907,024
1848	6,360,284	2,700,412	13,141,204	15,841,616
1849	6,651,240	956,874	4,447,774	5,404,648
1850	4,628,792	2,046,679	5,476,315	7,522,994
1851	5,453,592	18,069,580	11,403,172	29,472,752
1852	5,505,044	37,437,837	5,236,298	42,674,135
1853	4,201,382	23,548,535	3,938,340	27,486,875
1854	6,939,342	38,062,570	3,218,934	41,218,504
1855	3,659,812	53,957,418	2,289,925	56,247,343
1856	4,207,632	44,148,279	1,597,206	45,745,485
1857	12,461,799	60,078,352	9,058,570	69,136,922
1858	19,274,496	42,407,246	10,225,901	52,633,147
1859*	7,434,789	57,502,305	6,385,106	63,887,411
1860*	8,550,135	56,946,851	9,599,388	66,546,239
1861*	46,339,611	23,799,870	5,991,210	29,791,080
1862*	16,415,052	31,044,651	5,842,305	36,886,956
1863*	9,584,105	55,993,562	8,163,049	64,156,611
1864*	13,115,612	100,321,371	4,922,979	105,244,350
1865*	9,810,072	64,618,124	3,025,102	67,643,226
1866*	10,700,092	82,643,374	3,400,697	86,044,071
1867*	22,070,475	54,976,196	5,892,176	60,868,372
1868*	13,702,928	83,746,161	10,038,127	93,784,288

* From the manuscript records.

[1] From the Report of the Secretary of the Treasury—Finance Report—1868, p. 405.

TABLE VII.—EXPORTS OF GOLD AND SILVER

[Com]puted real value of the registered exports of gold and silver

Countries to which exported.	Total of gold and					
	1853.	1854.	1855.	1856.	1857.	1858.
Russia	£25, 309	....	£23, 295	£26, 342	£5, 517	....
Denmark	....	....	33, 097	5, 283	....	....
Prussia	....	....	5, 020	935	....	....
Hanse towns	2, 382, 088	£2, 041, 410	922, 797	997, 783	935, 886	£658, 639
Holland	1, 164, 097	906, 147	86, 665	178, 832	38, 033	682, 021
Belgium	1, 780, 042	791, 886	323, 498	1, 057, 165	333, 152	228, 109
France	5, 818, 563	13, 666, 907	10, 524, 090	10, 468, 294	11, 188, 329	10, 920, 647
Portugal, Azores, and Maderia	549, 077	365, 024	377, 224	148, 254	251, 105	127, 067
Spain and Canaries	....	2, 510	1, 647	1, 004	50, 743	60, 307
Gibraltar	28, 730	309, 127	226, 495	128, 576	425, 314	2, 634
Malta	21, 392	1, 507	389	1, 752	29, 203	....
Turkey	48, 479	640, 157	110, 037	118, 461	....	633, 802
Egypt	5, 417, 055	3, 754, 373	6, 072, 411	11, 220, 932	17, 601, 428	5, 220, 136
British Possessions in S. Africa	3, 547	....	1, 040	....	118, 097	67, 022
Mauritius	100, 169	15, 064	9, 157	155, 840	55, 541	132, 985
East Indies	536, 107	26, 352	19, 608	55, 047	1, 168	....
British settlements, Australia	942, 955	305	148	....	72	395
British North America	6, 150	15, 688	1, 033	4, 806	52, 421	6, 696
Danish West Indies	....	12, 982	....	5, 000	375, 963	204, 417
Spanish West Indies	21, 836	....	....	36, 438	175, 207	2, 079
United States	961	12, 869	2, 230	96, 227	859, 110	202, 567
Mexico	....	....	....	....	....	....
Central America	....	....	....	....	....	....
New Granada	....	....	....	....	14, 751	5, 372
Brazil	35, 036	2, 044	57, 445	95, 440	1, 012, 915	415, 795
Other countries	25, 160	22, 216	30, 852	49, 430	43, 013	37, 692
Total	18,906,753	22,586,568	18,828,178	24,851,797	33,566,968	19,628,876

[1] From "Statistical Abstract for the United Kingdom," 1853–1867, p. 84.

BULLION FROM THE UNITED KINGDOM.

bullion and specie from the United Kingdom to various countries.[1]

silver bullion and specie.

1859.	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.
£122, 287	£1, 573	....	£1,855,501	£2,707,857	£289	....	£8, 597	£34, 503
5, 712	....	....	....	164, 227	107, 734	£21, 792	100, 292	17, 400
1, 581	....	....	....	....	....	....	727, 281	14, 250
1, 280, 215	397, 379	£333, 968	243, 996	1, 462, 925	248, 995	565, 400	1, 591, 269	1, 281, 062
346, 623	134, 913	348, 680	425, 040	221, 356	543, 211	1, 027, 497	1, 362, 894	1, 219, 231
257, 429	211, 415	192, 375	334, 420	211, 305	265, 297	617, 982	1, 223, 965	1, 150, 030
15, 384, 371	11, 315, 346	2, 051, 041	7, 205, 663	4, 760, 984	9, 921, 524	4, 962, 865	10, 555, 361	8, 224, 648
395, 567	602, 476	337, 562	970, 267	638, 755	202, 029	82, 415	108, 519	62, 300
346, 352	756, 064	650, 246	1, 398, 078	1, 058, 826	1, 412, 724	1, 412, 408	158, 007	295, 533
109, 946	144, 906	53, 014	105, 470	52, 695	4, 594	....	6, 096	3, 075
....	51, 001	50, 000	389	184, 781	110, 482	30, 021	....	145, 727
3, 054	109	494	2, 029, 121	35, 534	33	303	....	....
16, 616, 531	9, 496, 122	8, 076, 334	12, 629, 830	12, 289, 430	8, 368, 122	4, 388, 522	2, 995, 871	889, 334
12, 478	50, 619	143, 464	....	165, 967	135, 417	19, 469	4, 867	70, 719
1, 392	....	2, 033	....	103, 218	....	....	....	....
....	....	....	....	....	....	....	....	....
103	29, 720	....	....	21, 382	8, 385	41, 202	46, 483	18, 360
26, 248	9, 000	645, 944	302, 121	131, 747	200, 621	83, 394	190, 336	96, 052
143, 070	50, 170	91, 643	184, 464	53, 608	126, 708	210	40, 689	41, 639
6, 628	41	110, 489	18, 864	95, 434	57, 527	24, 772	....	27, 434
14, 342	1, 727, 220	7, 381, 953	37, 528	54, 195	189, 731	65, 918	1, 015, 070	63, 679
....	....	873	14, 999	122, 472	12, 834	....	....	....
....	123	647	416, 094	10, 870	2, 409	3, 046	713	399
168, 491	12, 437	20, 823	541, 144	30, 712	25, 439	51	7, 063	20, 104
197, 062	524, 312	169, 813	452, 392	1, 731, 037	1, 069, 650	1, 376, 671	1, 033, 909	401, 761
249, 321	89, 819	150, 252	169, 910	234, 723	118, 545	368, 586	461, 329	247, 277
35, 688, 803	25, 534, 768	20, 811, 648	29, 326, 191	26, 544, 040	23, 132, 300	15, 092, 524	21, 638, 611	14, 324, 517

TABLE VIII.—IMPORTS AND EXPORTS OF PRECIOUS METALS—FRANCE.

Value of gold coin imported into and entered for home consumption in France, and the value thereof exported from France, distinguishing French produce.[1]

Years.	Total imports.	For home consumption.	Total exports.	French produce.
	£1,251,396	£1,251,276	£502,128	£499,698
	3,744,432	3,743,412	675,433	673,416
	1,671,156	1,597,860	1,281,192	1,253,269
	2,274,228	2,302,188	973,968	971,772
	4,495,716	4,500,192	2,238,960	2,228,840
1855	4,306,884	4,245,072	6,306,060	6,303,236
1856	7,683,168	7,680,252	3,579,948	3,566,288
1857	11,129,136	11,128,368	4,782,976	6,382,088
1858	12,067,612	12,040,504	2,606,766	2,603,760
1859	14,787,192	14,748,476	7,311,467	7,289,476
1860	7,663,136	7,658,400	5,103,290	5,093,685
1861	9,089,334	9,069,600	8,418,208	8,377,948
1862	12,251,544	11,312,632	9,061,849	7,813,960
1863	13,116,128	11,458,680	12,588,179	10,863,548
1864	15,942,588	14,155,908	14,028,865	12,241,718
1865	12,927,640	12,926,264	10,210,896	8,530,854
1866	25,760,168	25,752,444	12,218,806	11,219,068

TABLE IX.—IMPORTS AND EXPORTS OF PRECIOUS METALS—RUSSIA.

Value of gold coin imported into and exported from Russia.[2]

Years.	Imported.			Exported.		
	Foreign coin.	Russian coin.	Total.	Foreign coin.	Russian coin.	Total.
1860	£156,154	£126,873	£283,027	£87,442	£1,308,406	£1,395,[illegible]
1861	133,005	146,911	279,916	84,544	1,980,954	2,065,[illegible]
1862	161,443	105,781	267,224	288,047	5,036,504	5,324,[illegible]
1863	287,172	275,263	562,435	479,588	9,128,099	9,607,[illegible]
1864	....	....	....	....	....	....
1865	115,154	102,939	268,093	295,250	2,601,133	2,896,[illegible]
1866	148,131	72,158	220,289	93,743	3,097,494	3,191,[illegible]

[1] From the Report of the Royal Commission on International Coinage, p. 342. [2] Ibid.

—A STATEMENT OF THE WEIGHT, FINENESS, AND VALUE OF FOREIGN AND DOMESTIC GOLD AND SILVER COINS.[1]

Veight, fineness, and value of foreign and domestic coins.

	GOLD COINS.				
	Denomination.	Weight.	Fineness.	Value.	Value after deduction.
		Oz. dec.	Thous.		
......	Pound of 1852	0.281	916.5	$5 32.37	$5 29.71
	Sovereign of 1856–'60	0.256.5	916	4 85.58	4 83.16
......	Ducat	0.112	986	2 28.28	2 27.04
	Sovereign	0.363	900	6 75.35	6 71.98
	New Union crown, (assumed)	0.357	900	6 64.19	6 60.87
......	Twenty-five francs	0.254	899	4 72.03	4 69.87
......	Doubloons	0.867	870	15 59.25	15 51.46
......	Twenty milreis	0.575	917.5	10 90.57	10 85.12
ca....	Two escudos	0.209	853.5	3 68.75	3 66.91
	Four reals	0.027	875	0 48.8	0 48.6
......	Old doubloon	0.867	870	15 59.26	15 51.47
	Ten pesos	0.492	900	9 15.35	9 10.78
......	Ten thaler	0.427	895	7 90.01	7 86.06
......	Four escudos	0.433	844	7 55.46	7 51.69
......	Pound, or sovereign, new	0.256.7	916.5	4 86.34	4 83.91
	Pound, or sovereign, average	0.256.2	916	4 84.92	4 82.50
......	Twenty francs, new	0.207.5	899	3 85.60	3 83.67
	Twenty francs, average	0.207	899	3 84.69	3 82.77
h	Ten thaler	0.427	895	7 90.01	7 86.06
	Ten thaler, Prussian	0.427	903	7 97.07	7 93.09
	Krone, (crown)	0.357	900	6 64.20	6 60.88
h	Ducat	0.112	986	2 28.28	2 27.14
......	Twenty drachms	0.185	900	3 44.19	3 42.47
......	Mohur	0.374	916	7 08.18	7 04.04
......	Twenty lire	0.207	898	3 84.26	3 82.34
......	Old cobang	0.362	568	4 44.00	4 41.8
	New cobang	0.289	572	3 57.6	3 55.8
......	Doubloon, average	0.867.5	866	15 52.98	15 45.22
	Doubloon, new	0.867.5	870.5	15 61.05	15 53.25
	Twenty pesos, Maximilian	1.086	875	19 64.00	19 54.00
......	Six ducati, new	0.245	996	5 04.43	5 01.91
......	Ten guilders	0.215	899	3 99.56	3 97.57
......	Old doubloon, Bogota	0.868	870	15 61.06	15 53.26
	Old doubloon, Popayan	0.867	858	15 37.75	15 30.07
	Ten pesos, new	0.525	891.5	9 67.51	9 62.68
....	Old doubloon	0.867	868	15 55.67	15 47.90
	Twenty soles	1.035	898	19 21.8	19 12.02
......	Gold crown	0.308	912	5 80.66	5 77.76
......	New Union crown, (assumed)	0.357	900	6 64.19	6 60.87
......	Two and half scudi, new	0.140	900	2 60.47	2 59.17
......	Five rubles	0.210	916	3 97.64	3.95.66
......	One hundred reals	0.268	896	4 96.39	4 93.91
	Eighty reals	0.215	869.5	3 86.44	3 84.51
......	Ducat	0.111	975	2 23.72	2 22.61

ort of R. H. Lindermann, director of the United States mint, Philadelphia; also in the report of the Secretary of the Treasury for 1867, pages 331–2.

, and value of foreign and domestic coins—Continued.

Country.	GOLD COINS. Denomination.	Weight.	Fineness.	Value.	Value after deduction.
		Oz. dec.	*Thous.*		
Tunis	Twenty-five piastres	0.161	900	$2 99.54	$2 98.05
Turkey	One hundred piastres	0.231	915	4 36.93	4 34.75
Tuscany	Sequin	0.112	999	2 31.29	2 30.14
					Weight in grains.
United States	Dollar, (legal)	0.053.75	900	$1 00	25.8
	Quarter eagle	0.134.37	900	2 50	64.5
	Three dollar	0.161.25	900	3 00	77.4
	Half eagle	0.268.75	900	5 00	129
	Eagle	0.537.05	900	10 00	258
	Double eagle	1.075	900	20 00	516

Country.	SILVER COINS. Denominations.	Weight.	Fineness.	Value.
		Oz. dec.	*Thous.*	
Austria	Old rix dollar	0.902	833	$1 02.27
	Old scudo	0.836	902	1 02.64
	Florin before 1858	0.451	833	51.16
	New florin	0.397	900	48.63
	New Union dollar	0.596	900	73.05
	Maria Theresa dollar, 1780	0.895	838	1 02.12
Belgium	Five francs	0.803	897	98.04
Bolivia	New dollar	0.643	903.5	79.07
	Half dollar	0.432	667	39.22
Brazil	Double milreis	0.820	918.5	1 02.52
Canada	Twenty cents	0.150	925	18.87
Central America	Dollar	0.866	850	1 00.19
Chili	Old dollar	0.864	908	1 06.79
	New dollar	0.801	900.5	98.17
Denmark	Two rigsdaler	0.927	877	1 10.65
England	Shilling, new	0.182.5	924.5	22.96
	Shilling, average	0.178	925	22.41
France	Five franc, average	0.800	900	98.00
Germany, north	Thaler before 1857	0.712	750	72.67
	New thaler	0.595	900	72.89
Germany, south	Florin before 1857	0.340	900	41.65
	New florin, (assumed)	0.340	900	41.65
Greece	Five drachms	0.719	900	88.08
Hindostan	Rupee	0.374	916	46.62
Japan	Itzebu	0.279	991	37.62
	New itzebu	0.279	890	33.80
Mexico	Dollar, new	0.867.5	903	1 06.62
	Dollar, average	0.866	901	1 06.28
	Peso of Maximilian	0.861	902.5	1 05.50

Weight, fineness, and value of foreign and domestic coins—Continued.

Country.	SILVER COINS.			
	Denomination.	Weight.	Fineness.	Value.
		Oz. dec.	*Thous.*	
Naples	Scudo	0.844	830	$0 95.34
Netherlands	Two and a half guild	0.804	944	1 03.31
Norway	Specie daler	0.927	877	1 10.65
New Granada	Dollar of 1857	0.803	896	97.92
Peru	Old dollar	0.866	901	1 06.20
	Dollar of 1858	0.766	909	94.77
	Half dollar, 1835-'38	0.433	650	38.31
	Sol	0.802	900	98.24
Prussia	Thaler before 1857	0.712	750	72.68
	New thaler	0.595	900	72.89
Rome	Scudo	0.864	900	1 05.84
Russia	Rouble	0.667	875	79.44
Sardinia	Five lire	0.800	900	98.00
Spain	New pistareen	0.166	899	20.31
Sweden	Rix dollar	1.092	750	1 11.48
Switzerland	Two francs	0.323	899	39.52
Tunis	Five piastres	0.511	898.5	62.49
Turkey	Twenty piastres	0.770	830	86.98
Tuscany	Florin	0.220	925	27.60
				Weight in grains.
United States	Dollar, (legal)	0.859.375	900	412.5
	Half dollar	0.406	900	192
	Quarter dollar	0.200	900	96
	Dime	0.080	900	38.4
	Half dime	0.040	900	19.2
	Three cent	0.024	900	11.52

EXPLANATORY REMARKS.[1]

The first column embraces the names of the countries where the coins are issued; the second contains the names of the coin, only the principal denominations being given. The other sizes are proportional; and when this is not the case, the deviation is stated.

The third column expresses the weight of a single piece in fractions of the troy ounce, carried to the thousandth, and in a few cases to the ten thousandth of an ounce. The method is preferable to expressing the weight in grains for commercial purposes, and corresponds better with the terms of the mint. It may be readily transferred to weight in grains by the following rule:

Remove the decimal point; from one-half deduct four per cent. of that half, and the remainder will be grains.

[1] Appended to the tables by R. H. Lindermann.

The fourth column expresses the fineness in thousandths, *i. e.*, the number of parts of pure gold or silver in 1,000 parts of the coin.

The fifth and sixth columns of the first table express the valuation of gold. In the fifth is shown the value as compared with the legal contents or amount of fine gold in our coin. In the sixth is shown the value as paid at the mint after the uniform deduction of one-half of one per cent. The former is the value for any other purposes than recoinage, and especially for the purpose of comparison; the latter is the value in exchange for our coins at the mint.

For the silver there is no fixed legal valuation, the law providing for shifting the price according to the condition of demand and supply. The present price of standard silver is 122½ cents per ounce, at which rate the values in the fifth column of the second table are calculated. In a few cases, where the coins could not be procured, the data are *assumed* from the legal rates, and so stated.

NOTES ON FOREIGN COINS.

Mr. Linderman adds in his report the following observations on foreign coins:

"The silver *sol* of Peru, which is the successor of the peso or dollar, is found to be of standard fineness, and the average weight 0.802 ounce troy. The dates observed are 1864 to 1866.

"The Mexican silver peso or dollar of Maximilian, of the date 1866, averaged 902½ thousandths fine, and 0.861 ounce, or 413¼ grains, in weight, upon trial of a considerable quantity. These two reports are furnished by the assay office at New York.

"We have seen but one gold piece of Maximilian, called '20 pesos,' of the date 1866, and weighing 1.086 ounce, or 521¼ grains. We had not the opportunity of assaying it, being held as a curiosity; but the weight indicates that the doubloon fineness of 875 has been retained. On this assumption we place it in the table.

"I will here add the result of a recent assay of single gold pieces of France, of the dates 1863 to 1867, and mint marks of Paris and Strasbourg. This is important in its bearing upon the question of international coinage; for if such an interchange is to take place, the respective countries must keep good faith in regard to the fineness of their coins, otherwise the matter will soon come to an end. We find the fineness varying from 898.5 to 899.8, and averaging 899.2. This has generally been the result for many years, and is not what should be expected. The average ought to be 900, as required by law. The British coins are kept up to the mark."

In the report of the Secretary of the Treasury for 1868, Mr. Linderman says:

"Our silver dollar is not received by the Chinese except at a discount. This is owing to the fact that while it is of equal fineness with the

Spanish or Mexican dollar, it is about one per cent. less in weight. This rejection seems to take away the last plea for continuing to coin this piece.

"We have some interesting details on this subject from the master of the British mint at Hong-Kong, established there a few years since for the purpose of furnishing a silver currency, with the Mexican dollar as its basis.

"The mint has recently been discontinued; but while it lasted its issues were acceptable to the Chinese traders, although the chief part of the coinage found its way to Singapore and the region thereabouts. Fractional parts of the dollar were also struck, both in silver and copper, and it is curious to observe that they followed our centesimal notation, issuing pieces of ten cents, five cents, one cent, and other denominations."

TABLE XI.—WEIGHTS, FINENESS, AND TOLERANCE OF THE PRINCIPAL GOLD COINS.

[Supplied by Thomas Graham, esq., Master of the Royal Mint, in the Report of the Royal Commission on International Coinage, page 227.]

Country.	Coin.	Weight in grains.	Alloy.	Fine gold in grains.	Fine gold in grams.	Tolerance weight.	Fineness.	Mintage, (Frais de Fabrication.)	Loss by wear allowed.
Great Britain	Sovereign	123.274	$\frac{1}{12}$	113.001	7.3225	$.00208\frac{1}{3}$	$.002\frac{29}{48}$	None	Reduced to 122.500 grs.
	Half sovereign	61.637	$\frac{1}{12}$	56.501	3.6612	$.00208\frac{1}{3}$	$.002\frac{29}{48}$	None	Reduced to 61.125 grs.
France, Belgium, Switzerland, and Italy.	25-franc piece	124.452	$\frac{1}{10}$	112.006	7.2581	.002	.002	.00216*	Reduced to 123.581 grs.†
	20 franc	99.56	$\frac{1}{10}$	89.604	5.8064	.002	.002	.00216	
	10 franc	49.78	$\frac{1}{10}$	44.802	2.9032	.002	.002	.00216	
	5 franc	24.89	$\frac{1}{10}$	22.401	1.4516	.003	.002	.00216	
United States of America	Eagle, (10 dollars)	258.00	$\frac{1}{10}$	232.200	15.0466	.00387	.002	.005	
	Half eagle	129.00	$\frac{1}{10}$	116.100	7.5233	.00387	.002	.005	
	Dollar	25.80	$\frac{1}{10}$	23.220	1.5047	.00969	.002	.005	
Prussia	Friedrichs d'or, F. Wm. III, 1831	103.12	$\frac{902.778}{1000}$	93.09	6.0323	.0025	None	....	
Zollverein	Krone, (crown,) F. Wm. IV, 1859	171.467	$\frac{1}{10}$	154.323	10.000	.0025	.002	.004	.0025
	Half krone of F. Wm. IV, 1858	85.7335	$\frac{1}{10}$	77.160	5.000	.0025	.002	.004	.0025
Austria	Reichsducaten, ducat of Francis Joseph I, 1860.	53.858	$\frac{986.111}{1000}$	53.110	3.441	....	About .002	....	
Spain	Doubloon of 10 escudos	129.43	$\frac{1}{10}$	116.48	7.547	.00584	.002	None	.00584
Portugal	Crown of 10,000 reis	273.71	$\frac{1}{12}$	250.90	16.261	....	....	....	
Brazil	Ten mille reis piece	139.35	$\frac{1}{12}$	126.82	8.218	....	....	....	

Denmark	Christian d'or	[illegible]	[illegible] / 1000	[illegible]	[illegible]	...			
Egypt	Fifty piastre piece	66.00	$\frac{874}{1000}$	57.68	3.738	...	...	...	
Greece	Twenty drachmai piece	89.14	$\frac{1}{10}$	80.22	5.198	.002	.002	...	
Holland	Double William	207.68	$\frac{1}{10}$	186.92	12.112	...	...	...	
Holland	Double ducat	107.84	$\frac{983}{1000}$	106.01	6.870	...	...	...	
Malta	Doppia, or pistole	127.78	...	109.12	7.071	...	...	...	
Rome	Ten scudi piece	267.54	$\frac{1}{10}$	240.78	15.602	...	...	...	
Russia	Half imperial of 5 roubles	100.99	$\frac{1}{12}$	92.58	6.000	.0051	None	None	.0087
Sweden	Ducat	53.78	$\frac{975.610}{1000}$	52.47	3.400	.003	.003	.003	
Turkey	Lira of 100 piastres	111.36	$\frac{1}{12}$	102.01	6.610	.002	.002	.01	

* 6.70 francs on 3,100.

† The loss by wear allowed on the French 20 and 10 francs is 0.7 per cent., inclusive of the tolerance of 0.2 per cent.; on the British sovereign, 0.628 per cent.

TABLE XII.—PRODUCTION OF GOLD.

[A]pproximate production of the principal gold fields of the world, according to Phillips.[1]

	1800.		1850.		1860.		1865.	
	Pounds troy.	Ratio per cent.	Pounds troy.	Ratio per cent.	Pounds troy.	Ratio per cent.	Pounds troy.	Ratio per cent.
[illegible]	1,440	2.7	65 600	19.0	66,000	11.3	69,500	12.4
[illegible]	3,500	6.5	5,600	1.6	5,500	1.0	5,500	1.0
...ope			100	....	350	....	375	....
[illegible]	10,000	18.5	[illegible]	7.3	25,000	4.3	25,000	4.5
[illegible]	600	1.2	[illegible]	1.1	4,000	0.7	4,000	0.7
[illegible]	7,500	13.8						
[illegible]	1,600	3.0						
[illegible]	2,400	4.4	34,000[2]	9.9	34,000	5.9	34,000	6.1
...Granada	12,600	23.4						
Brazil	10,000	18.5						
Mexico	4,300	8.0						
California and neighboring States and Territories	....	....	208,000	60.2	187,000	31.9	210,000	37.5
Rest of United States	....	....	2,950	0.9	1,020	0.2	140	....
Nova Scotia	....	....	....	....	....	....	2,072	0.4
British Columbia	....	....	....	....	20,000	3.4	11,600	2.1
Australia	....	....	....	....	217,500	37.0	156,000	27.9
New Zealand	....	....	....	....	25,000	4.3	41,400	7.4
Total	53,940	100.00	345,250	100.00	585,370	100.00	559,587	100.00

[1] The Mining and Metallurgy of Gold and Silver, page 127.

[2] The yields of the different members of this group vary considerably from year to year, but the aggregate product is believed to remain tolerably constant.

TABLE XIII.—PRODUCTION OF SILVER.

Table showing the approximate yield of the principal silver-producing countries, according to Phillips.[1]

	1800.		1850.		1865.	
	Pounds troy.	Ratio per cent.	Pounds troy.	Ratio per cent.	Pounds troy.	Ratio per cent.
Russian empire	58,150	2.5	60,000	2.1	58,000	1.5
Scandinavia			20,400	0.7	15,000	0.4
Great Britain			48,500	1.7	60,500	1.5
Hartz			31,500	1.1	28,000	0.6
Prussia			21,200	0.7	68,000	1.7
Saxony	141,000	6.0	63,600	2.2	80,000	2.0
Other German states			2,500	0.1	2,500	....
Austria			87,000	3.1	92,000	2.2
France			5,000	0.2	18,000	0.4
Italy			....	....	[2] 25,000	0.6
Spain			125,000	4.4	110,000	2.8
Australia, New Zealand, British Columbia, and Nova Scotia	....	....	10,000	0.4	9,500	0.2
Chili	18,300	0.8	238,500	8.4	299,000	7.3
Bolivia	271,300	11.6	130,000	4.6	136,000	3.3
Peru	401,850	17.2	303,150	10.7	299,000	7.4
New Granada	5,000	0.2	13,000	0.5	15,000	0.4
Brazil	1,200	....	675	....	1,500	0.4
Mexico	1,440,500	61.7	1,650,000	58.4	1,700,000	42.3
United States	....	....	17,400	0.7	1,000,000	25.0
Total	2,337,300	100.00	2,827,425	100.00	4,017,000	100.00

[1] The Mining and Metallurgy of Gold and Silver, page 320.

[2] Obtained from the island of Sardinia, where it is found associated with galena.

TABLE XIV.—PRODUCTION OF THE PRECIOUS METALS, ACCORDING TO BIRKMYRE—1846 and 1850.

Comparative table showing the annual produce (approximate calculation) in value of fine gold and silver for 1846 and 1850, the first being two years before the discovery of the rich deposits of gold in California, the latter two years after the discovery.

Countries.	1846.			1850.		
	Gold.	Silver.	Total.	Gold.	Silver.	Total.
California	....	....	....	£12,000,000	£62,088	£12,062,088
United States	£237,336	£1,864	£239,230	115,430	11,444	126,874
Mexico	249,753	3,457,020	3,706,773	382,901	5,383,333	5,766,234
New Granada	252,407	42,929	295,336	252,407	42,929	295,336
Peru	96,241	1,000,583	1,096,824	96,241	1,000,583	1,096,824
Bolivia	60,337	460,191	520,548	60,357	460,191	520,548
Chili	145,585	297,029	442,614	145,585	297,029	442,614
Brazil	259,871	2,003	261,874	289,068	2,227	291,295
Total of N. and S. America	1,301,560	5,261,619	6,563,179	13,341,989	7,259,824	20,601,813
Russia	3,414,427	167,831	3,582,258	4,175,860	171,817	4,347,677
Norway	....	32,346	32,346	....	35,607	35,607
North Germany	357	138,022	138,379	357	138,022	138,379
Saxony	....	198,200	198,200	....	198,200	198,200
Austria	282,750	282,654	565,404	288,708	286,971	575,679
Piedmont	17,841	7,444	25,285	17,841	7,444	25,285
Spain	2,498	227,499	229,997	2,498	440,210	442,708
United Kingdom	....	109,989	109,989	....	160,000	160,000
Africa	203,900	1,056	204,956	203,900	1,056	204,956
Borneo	305,900	1,584	307,484	305,850	1,584	307,484
Ava	100,000	517	100,517	100,000	517	100,517
Malacca	72,240	374	72,614	72,240	374	72,614
Sumatra	63,719	330	64,049	63,719	330	64,049
Annam or Tonquin	30,585	53,460	84,045	30,585	53,460	84,045
Various countries [1]	50,975	33,000	83,975	50,975	33,000	83,975
Total of Europe, Africa, and Asia	4,545,192	1,254,306	5,799,498	5,312,533	1,528,592	[illegible]
Total of North and South America	1,301,560	5,261,619	6,563,179	13,341,989	7,259,824	20,601,813
Total	5,846,752	6,515,925	12,362,677	18,654,522	8,788,416	[illegible]

[1] Exclusive of China and Japan, which produce large quantities of gold and silver, the amount of which is quite unknown to Europeans.

APPENDIX E.

METRICAL AND OTHER WEIGHTS AND THEIR EQUIVALENTS.

For the convenience of those who consult this report, the metric system of weights, with the equivalents of its denominations in troy and avoirdupois weights, are given below, together with equivalents and values of some other systems of weights and values.

In the foregoing pages, for the conversion of figures given in pounds (£) sterling into dollars, when exact figures were not essential, as in the case of estimates and round numbers, $5 has been taken as the equivalent of the £; and when sums expressed in francs have been converted into dollars, 5 francs has been taken as the equivalent of one dollar. In calculating the value of amounts of silver expressed in troy ounces, the ounce has been reckoned as worth $1 25. For native gold the value per ounce has been reckoned as at from $16 to $20, according to the source of production. In the statistics of yield of gold and silver in the United States, when tons are mentioned, a net or "short" ton of 2,000 pounds avoirdupois is intended, unless it is otherwise stated.

Table of metric weights and their equivalents in avoirdupois and troy weights.

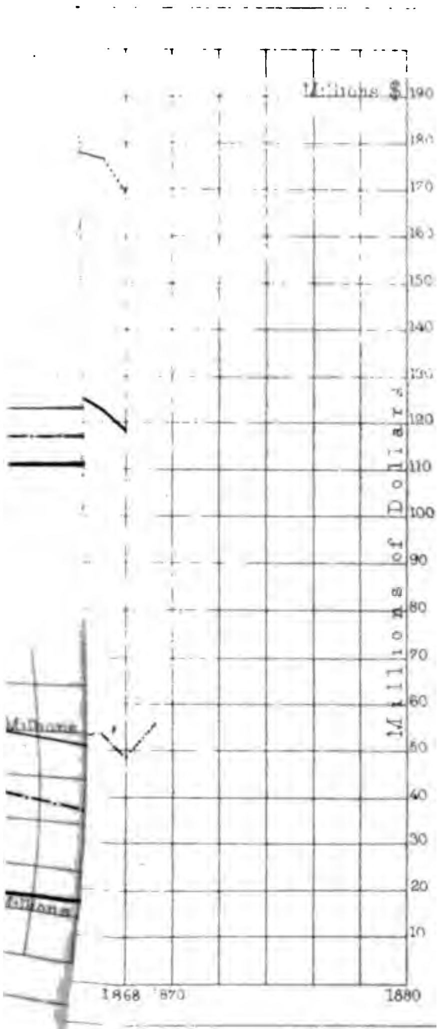
Metric system of weights.		Equivalents in—	
Names.	No. of grams.	Avoirdupois weight.	Troy weight.
Millier or tonneau	1000000	2204. 6 pounds	32150 ounces.
Quintal	100000	220. 46 pounds	3215 ounces.
Myriagram	10000	22. 046 pounds	321. 5 ounces.
Kilogram, or kilo	1000	2. 2046 pounds	32. 15 ounces.
Hectogram	100	3. 5274 ounces	3. 215 ounces.
Decagram	10	0. 3527 ounce	0. 3215 ounce.
Gram	1	15. 432 grains	15. 432 grains.
Decigram	0. 1	1. 5432 grains	1. 5432 grains.
Centigram	0. 01	0. 1543 grain	0. 15432 grain.
Milligram	0. 001	0. 0154 grain	0. 01543 grain.

Denominations of weights of various countries and their equivalents in the metric and other systems.

	Equivalent in the metric system.	Equivalent in avoirdupois weight.	Equivalent in troy weight.
Avoirdupois pound (lb.)	453.60 grams	1 pound	1.2153 pound.
Troy pound (lb.)	373.24 grams	.8228 pound	1 pound.
Troy ounce (oz.)	31.10 grams		1-12 pound.
Livre (France)	.41 kilog	0.90389 pound	
Livre (Russia)	.41 kilog	0.90389 pound	
Pood (Russia)	16.380 kilog	36.117 pounds	
Zolotnik (Russia)	4.266 grams		65.833 grains.
Mark (Norway and Sweden)	210.72 grams		3252 grains.
Oitava (Brazil)	3.584 grams		55.343 grains.
Centner (Vienna)	56.902 kilog	125.442 pounds	

ERRATA.

Page 177, last line, for "2,375," read 2.375.
Page 182, in the table, for "176,782," read 17,678.2.
Page 184, last line, for "3.252 grams," read 3252 grains.
Page 301, lines 13 and 15, for "grains," read grams.
Page 322, line 27, for "Nearly" read Near.



J. Bien, Lith. N.Y

INDEX.

A.

B.

C.

D.

E.

F.

G.

H.

I.

N.

R.

S.

T.

ARIS UNIVERSAL EXPOSITION, 1867.

OF THE UNITED STATES COMMISSIONERS.

THE PROGRESS AND CONDITION

OF

SEVERAL DEPARTMENTS

OF

ЈSTRIAL CHEMISTRY.

BY

J. LAWRENCE SMITH,

UNITED STATES COMMISSIONER.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1869.

CONTENTS.

INTRODUCTION.

CHAPTER I.

THE MANUFACTURE OF SULPHURIC ACID.

CHAPTER II.

SODA AND SALTS OF SODA.

CHAPTER III.

POTASH AND ITS COMPOUNDS.

CHAPTER IV.

AMMONIA, BARYTA, MAGNESIA, AND ALUMINA.

CHAPTER V.

CHLORINE, FLUORINE, MANGANESE, AND CARBONIC ACID.

CHAPTER VI.

INDUSTRIAL PRODUCTION OF OXYGEN, HYDROGEN, AND OTHER ELEMENTS.

CHAPTER VII.

MANUFACTURE OF ILLUMINATING GAS FROM COAL, AND THE UTILIZATION OF THE WASTE PRODUCTS.

CHAPTER VIII.

STEARIC ACID INDUSTRY.

DESCRIPTION OF THE PLATES.

APPENDIX.

LIST OF PLATES.

[To be placed at the end of the report.]

INDUSTRIAL CHEMISTRY.

INTRODUCTION.

No department of the Exposition of 1867 is more pre-eminent in importance than Class 44, embracing chemical products and chemical processes. In fact, industrial chemistry links itself with every modern art in such an intimate manner, that were we to take away the influence and results of chemistry it would be almost like taking away the laws of gravitation from the universe. Industrial chaos would result in one case, as material chaos would in the latter. The miner, the metallurgist, the machinist, the weaver, the paper maker, the painter, the glass maker, the fine arts, all draw from the rich storehouse of chemistry. To these we must add the new arts born directly from the same source, viz: photography, galvanoplasty, gilding and silvering metals, dyeing with new colors obtained from coal, vulcanized India-rubber, stearine candles, sugar from starch and wood, &c.

No one can paint in too vivid colors the sum of indebtedness the civilized world is already under to the chemist, and no enthusiast can transcend in his wildest speculations what we are yet to realize. The chemical arts in their strictest sense do not simply aid the other arts, but they keep in activity a vast amount of capital, and consequently give employment to a large number of individuals, skilled and unskilled. In France alone the annual value of chemical products is $250,000,000, of which $125,000,000 represent the articles of sulphuric acid, soda, soap, India-rubber, and candles. Of chemical products, France exports $20,000,000 worth, the remainder being consumed at home in giving activity to other industries whose products are largely exported in the form of woollen, cotton, and silk stuffs, &c.

The above statement represents the activity of industrial chemistry in but one country; yet every part of the civilized world is more or less engaged in the manufacture of chemicals, as the extensive and beautiful collections in the present Exposition demonstrate. These collections are placed there by 1,548 exhibitors, divided as follows: France, 358; England, 108; Belgium, 85; Prussia, 125; Austria, 150; other parts of Germany 55; Switzerland, 37; Spain, 57; Portugal, 16; Sweden, 14; Norway, 25; Russia, 71; Italy, 200; America, 30; Holland, 40; Denmark, 10; Algiers, 44; Greece, 25; Turkey, 99; Egypt, 2; China, 2; Brazil, 98; other parts of South America, 5.

In addition to the number of chemical works it is well to notice their size, for in many of them the operations are conducted on a gigantic

scale; as, for instance, in the works of Messrs. Allhuson & Sons, at Newcastle-on-Tyne, which, although not the largest, consumes *weekly* the following enumerated materials, in tons: coal, 2,250; pyrites, 350; nitrate of soda, 10; chalk, 900; salt, 450; manganese, 100; lime, 125.

The weekly production is: 450 tons crystallized soda, 150 tons refined alkali; 100 tons bicarbonate soda; 30 tons of caustic soda; and 110 tons chloride of lime—in all, 830 tons chemical products; enough to freight a good-sized ship.

It is not the province of this report to detail the general character of the articles exposed by the different exhibitors, except so far as this or that article may possess some special merit.

Industrial chemistry has its greatest expansion and widest range of production in France and England, especially as regards what are called the staple articles; but in the manufacture of many of the less abundant products Germany is not surpassed, and in the last five or ten years has taken rapid strides towards competing successfully with France and England in the manufacture of almost all substances.

Of course, a necessarily hurried and somewhat confused examination of the great variety of products found in the Exposition must interfere with a very satisfactory criticism in many points; and as to the processes, a knowledge of them could only be obtained from more or less imperfect descriptions by the exhibitors, except when time afforded an opportunity to visit the factories, and where the owners were willing to be communicative, and allowed free access to all the apparatus when in operation.

The most striking progress, since 1862, is the invention of new colors from coal-tar, (toluidine and methylaniline,) better known as aniline colors, but especially in the improvement in the quality, and a wonderful diminution in the cost of those previously known; the transformation of naphthaline into benzoic acid; the manufacture on a large scale of fluosilicic acid, destined to play an important part in the manufacture of soda and potash; and finally, other inventions and improvements which will be alluded to in detail in this report. It is proper, however, to state that the progress of the chemical arts during the past five years has not been so remarkable for any great discovery of new processes as it has been in perfecting those which had already been employed, so as to furnish more abundant and cheaper products.

In this report the labors of the scientific men with whom I had the good fortune to be associated will be used whenever required, and without reserve, when it is conceived necessary to furnish correct and useful information to the American public; and I take this opportunity to acknowledge my indebtedness to the kindness of my associates on juries, and in the grand council, among whom I would enumerate the French and continental chemists MM. Ballard, Dumas, Liebig, St. Claire Deville, Bouterêlle, Kuhlmann, Daubrée, Hofmann, and others.

The natural subdivisions of the products of industrial chemistry bring into the foreground the acids and the alkalies. As they constitute the substructure of the chemical arts, and as of this substructure sulphuric acid is the corner stone, this acid and its manufacture will be viewed in all its bearings upon the chemistry of the Great Exposition of 1867.

INDUSTRIAL CHEMISTRY.

CHAPTER I.

THE MANUFACTURE OF SULPHURIC ACID.

IMPORTANCE OF THIS ACID TO THE USEFUL ARTS—VARIOUS METHODS PROPOSED TO AVOID THE USE OF CHAMBERS—SUBSTANCES EMPLOYED IN THE MANUFACTURE—SULPHUR, EXHIBITION OF, AND PRINCIPAL SOURCES—SULPHUR FROM SODA-WASTE—BLACK-ASH, MOND'S PROCESS—SULPHUR FROM COAL GAS—FROM PYRITES—METHODS AND PROCESSES OF MANUFACTURE—SULPHUR FURNACES—LEAD CHAMBERS—PYRITES FURNACES—GERSTENHOFFER'S FURNACE—UTILIZATION OF THE RESIDUE FROM THE PYRITES FURNACE—COMBUSTION OF PYRITES COMPARED WITH THAT OF SULPHUR—OXIDATION OF SULPHUROUS ACID—EFFORTS TO PRODUCE SULPHURIC ACID WITHOUT THE AGENCY OF NITRIC ACID—GAY LUSSAC'S PROCESS—PURIFICATION OF THE ACID FROM ARSENIC—CONCENTRATION OF SULPHURIC ACID—PLATINUM STILLS—DESCRIPTION IN DETAIL OF THE CONSTRUCTION OF SULPHURIC ACID WORKS.

I.—APPLICATIONS AND PROGRESS OF THE MANUFACTURE.

When we glance over the chemical products that influence to the greatest extent the useful arts of society, we find them among the acids and alkalies; for by the chemical reaction of these compounds, furnished by nature or art, the manufacturing and domestic arts generally obtain a multitude of useful compounds. But of all substances that have made their imprint on the modern progress of the arts, there is no one approaching sulphuric acid in importance, produced as it is from the cheapest materials furnished by nature, and of which there seems to be inexhaustible supplies. Glass making, soap making, bleaching, calico printing, dyeing, &c., are all large debtors to sulphuric acid. It is said that the consumption of sulphuric acid in any country will show, with that of iron, its industrial activity. The low price of the acid is one of its great merits; the ordinary form known as oil of vitriol, being the most concentrated form in ordinary use, is now made in France at a cost of about one and a quarter cent per pound, and in England for a shade less; in this country ill-advised legislation makes a much higher and fluctuating price.

No material change has taken place in the last ten years or more in the manufacture of sulphuric acid. The well-known method of converting sulphur into sulphurous acid, and completing the oxidation of it by the oxygen of the air, aided by one of the oxygen compounds of nitrogen, is still the predominant method, and, in fact, all of this acid that is manufactured, except the small quantity made by distilling copperas, and called Nordhausen acid, is made by this process.

It will not, however, be unprofitable to the readers of this report to enumerate some of the various attempts made in the last twenty years to supplant the present method in lead chambers. Lealand and Deacon,

in 1854, suggested the use of chambers made of stone, or earthenware. Simon, in 1860, proposed vulcanized gutta-percha, but on trial this substance was found more destructible than lead. Peter Ward, in 1862, proposed a series of glass sheets to increase the surface and hasten the reaction; that, however, had been used before, and as the formation of sulphuric acid is not dependent on surface action, it is of no advantage. Philips and Kuhlmann, as far back as 1838, proposed the use of heated air, and sulphurous acid passed over spongy platinum, but this has been almost forgotten. Fouché and Lepelletier, in 1850, employed a series of large Woolfe bottles instead of the lead chambers, at Javelle near Paris, but this has been long since abandoned. Kuhlmann proposed to pass a mixture of sulphide of hydrogen, obtained by proper means from soda waste, through nitric acid in stone-ware bottles, but the method was never put in practice. Petrie, in 1860, applied a system of stone-ware columns, filled with pebbles, through which currents of nitric acid and sulphurous acid in proper proportions were passed; but this has not been successfully applied. Several years ago Persoz accomplished the oxidation "by passing the sulphurous acid gas through nitric acid, diluted with from four to six volumes of water, and heating to 212° F., or through a mixture of nitric acid, or a nitrate with hydrochloric acid. The reaction takes place in a comparatively small vessel of suitable material; the gas arising from the deoxidation of the nitric acid is reconverted into nitrous acid by air and water. Theoretically, it works without a loss of nitric acid; nevertheless the process has never been adopted in practice, possibly from want of suitable material to withstand the combined action of the two strong acids."

II.—SUBSTANCES EMPLOYED IN THE MANUFACTURE OF SULPHURIC ACID.

SULPHUR.

There was a most beautiful display of specimens of sulphur from the south of Italy and from Sicily; and these countries furnish all the sulphur that is employed in the arts and in agriculture, except some little that is employed for domestic use in countries producing it, of which notice will be taken a little further on. While we now obtain the larger proportion of sulphuric acid made in Europe from pyrites, it is very much to be desired that new and abundant supplies of sulphur may be found, for the acid made from this substance directly is purer, and the apparatus required less expensive, than when pyrites is used. Besides the sulphur exhibited from southern Italy and Sicily, there were specimens from Apt, in France, which locality furnishes a poor sulphur mineral. Also in the neighborhood of Constantine, in Algiers, there is native sulphur. In central Italy, near Bologna, there is a vein of sulphur ore about fifteen miles long, but the mineral is not rich, and is necessarily taken from a great depth, sometimes over 800 feet. About 12,000 tons are produced here annually, which is almost entirely consumed in

the neighboring country for diseases of the vine. From the Papal States there were also specimens of sulphur, but the quantity produced there is very small, not exceeding 500 tons. The Spanish specimens come from Murcia and neighboring localities, where there are some fine mines of sulphur. Besides the above, there were specimens on exhibition from Galicia, near Cracovy, from Corinthia, in Hungary, from the Grecian island of Milo, from Tripoli, Isthmus of Suez, on the borders of the Red sea, province of Rio Grande, in the north of Brazil; but, as already stated, it is from Sicily that we obtain the great bulk of sulphur used in the arts. In this island the strata of sulphur extends over a length of about 170 miles, superimposed one on the other to a depth of from three to 25 feet and containing about 30 per cent. of sulphur. The mines are owned by various influential individuals, who, by restricting the supply and by rude and imperfect mining, keep up the price to the present standard. There have been as many as 1,000 mines opened, but at the present time not more than one-half are worked.

The manner of obtaining the sulphur has been frequently described, and was formerly of a very crude character. The method now in most frequent use is that of Tucci, the inspector of mines of Catanisette and Catania. It is by means of a species of furnace called *calcarones*, by which very large amounts of the mineral can be operated upon at once. These *calcarones* are simply circular furnaces of a conical form, having an inclination of from 20° to 45° according to the nature of the gangue, (which is calcareous or of gypsum,) so that the viscous sulphur can descend and run off at the bottom. The walls of the furnace are about one foot thick and ten feet deep and made of a capacity to hold more than 1,000 cubic yards of the ore; at the bottom of the furnace there is a hole to run off the melted sulphur, being the outlet of a channel coming from the interior of the furnace, which channel is continued for a little distance outside of the furnace, and is branched and arched over by laying masses of the mineral so as to form little tunnels leading to a reservoir.

The furnace is charged by putting large lumps in the middle, and then smaller fragments on the outside, and finally covering all over with previously exhausted ore. Around the upper part of the furnace are several small chimneys going down a foot or two; by these the furnaces are kindled at the top and air is supplied by percolation from above. One operation requires about twelve or fourteen days. The sulphur which has been collected in the reservoirs is cast into molds. The furnace requires twelve or fourteen days to cool down, when it is cleaned out and recharged; and this operation is repeated so long as the furnace lasts.

There are recent processes of separation proposed by Fangére, and by Emile and Pierre Thomas, depending on heat, but they deserve no special notice.

The most novel method is that of Deiss, viz., to dissolve out the sul-

phur by sulphuret of carbon, and an apparatus has been erected to extract by his process several tons of sulphur daily, but practical difficulties still exist and prevent it from becoming a complete success.

The quantity of sulphur produced in Sicily has gradually increased from 46,000 tons in 1832, to 300,000 tons at this time, worth from \$22 to \$24 a ton at the port of exportation. This increased consumption of sulphur, in spite of the diminished use of it in the chemical arts, (for it will be shown a little further on that pyrites to the amount of 800,000 tons, representing 250,000 tons of sulphur, has taken its place,) is due to the very large and increasing amount used for preventing diseases of the vine—diseases that have been almost exterminated by its use; but its use is kept up, as it is considered of great importance to give the vineyards an annual treatment of sulphur. If, however, sulphur should fall in price a little below what it is now, it would again come into general use in the manufacture of sulphuric acid.

SULPHUR FROM SODA-WASTE.

In the German section were shown the results obtained by the process of M. Mond, a chemist, of Utrecht, by which he extracts sulphur from soda-waste. The soda-waste has ever been a great nuisance, as well as a great loss in the manufacture of soda by Leblanc's process. It has become so great a nuisance in many of the large factories, that stringent sanitary laws have been passed concerning the disposal of it; and in some places, where it has been scattered over large surfaces, birds have been known to be asphyxiated while flying over it, and to fall to the ground. A large amount of sulphur is thrown away in this waste, so that for forty or fifty years chemists have endeavored to solve the problem of turning it to some account. The prospects now are that it can be made to yield up much of its sulphur, and the residue to furnish a valuable fertilizing agent, instead of a pestilential nuisance. Some idea may be formed of the abundance of this waste when it is stated that for every ton of alkali manufactured one and a half ton of dry waste is produced, furnishing the accumulations referred to, that during moist and rainy weather emit sulphuretted hydrogen gas, and in solution, poisoning waters of all kinds in the neighborhood. Besides the process of Mond there are two others brought forward, one by M. Schaffner, and the other by P. W. Hoffman; and seven works exhibit sulphur prepared by one or other of these processes. All the processes are based on the same principle—the conversion of the insoluble sulphide of calcium in the waste into soluble compounds, by bringing it freely in contact with air, in order to oxidize it; lixiviation of the oxidized mass, and precipitation of sulphur in these liquids by a strong acid, as muriatic acid.

BLACK-ASH—MOND'S PROCESS FOR OBTAINING SULPHUR.

I propose giving a tolerably full account of Mond's process, as described by himself, in using the waste from the black-ash generally employed in

England, and which allows of more rapid operation than the more compact waste of most continental works.

In place of the set of four vats generally in use for lixiviating black-ash, he employs a set of ten or twelve. All of these are connected by pipes in the usual way, so that the soda liquor runs from the bottom of one vat to the top of the next one, and by special pipes and taps which allow the sulphur liquor to run out of the bottom of each vat to the top of any other vat in the set. Besides this, they are provided with extra taps and shoots to convey the sulphur liquor to wells or settlers. The lower parts of all the vats are connected with a fan, (capable of producing a pressure of about seven inches of water,) by pipes furnished with dampers, which regulate the quantity of air passing through.

A noiseless fan of Schiele's construction, twenty inches diameter, price $50, propels a sufficient quantity of air for the treatment of the waste resulting from 100 tons of salt cake per week. Four of the vats are always filled with black-ash in the course of lixiviation; the other six or eight with waste to be treated according to the invention. As soon as the black-ash is completely spent, and the weak liquor is well drained off, the connection with the fan is opened. The waste soon begins to heat, the temperature gradually rising above 200° F., and gives off quantities of steam, becoming greenish, and afterwards yellow on top, gets more and more dry, and would take fire if the air was passed through long enough. The time for discontinuing the passing of air, so as to have the best results, must be ascertained in each establishment by experiments, and varies according as much or little hyposulphite in the hydrosulphide and bisulphide of calcium are formed, which are afterwards oxidized into hyposulphite. A part of the hyposulphite is again decomposed into sulphur and sulphite, which is very insoluble, and cannot be extracted by lixiviation. Carrying the oxidation too far would therefore entail a serious loss. On an average the time of exposure will be limited to between twelve and twenty-four hours. The waste is now lixiviated systematically with cold water, the weaker liquors passing from one vat to the next one in course of lixiviation, so as to obtain only strong liquors, which operation can be easily performed in six to eight hours. When this lixiviation is finished, air is again passed through the waste in exactly the same way as before; the waste is again lixiviated, and the same treatment is repeated a third time. The vat is then ready to be cast, and is again filled with black-ash. When the operations have been well conducted, sulphur equal to about 12 per cent. of the weight of the salt cakes used in making black-ash is obtained in solution from the waste. The waste contains only traces of sulphide of calcium, and is principally composed of carbonate of lime, sulphite and sulphate of lime, which, far from being noxious, make the waste, on the contrary, a valuable manure. In separating the sulphur from the liquors thus obtained, by adding muriatic acid, I met with much more difficulty than I had anticipated from apparently such a reaction.

The oxidation of the waste is regulated so as to obtain a liquor, which contains as nearly as possible to every equivalent of hyposulphite two equivalents of sulphide. This liquor is decomposed by first adding to a certain small quantity of acid an excess of liquor, until there is a trace of sulphide in the mixture; then a quantity of acid sufficient to neutralize the whole of the calcium is poured in; a new quantity of liquor equivalent to this last quantity of acid is added, and then acid again and liquor again, and so on until the vessel is nearly filled. To the last liquor only one-half of the required acid is added, and steam introduced until the liquid shows a temperature of about 140° F. Practically speaking, the liquor and acid are poured at the same time into the decomposing vessel in nearly equivalent proportions, the workmen taking care to keep a small excess of liquor up to the end of the operation. This part of the process is carried on in covered wooden tanks connected with a chimney in order to carry off any sulphuretted hydrogen which may be evolved by mistake of the workman. If properly carried out there should be, however, no appreciable quantity of that gas evolved.

The practical result of this mode of working is simply precipitation of nearly the whole of the sulphur in a pure state.

$$\mathrm{Ca\,O,\,S_2\,O_2 + Ca\,S_x + 3\,H\,Cl = 3\,Ca\,Cl + 3\,H\,O + (2+x)\,S.}$$

The details of the reaction are, however, very complicated, almost all the different acids of sulphur being probably formed during the process.

In practice, about 90 per cent. of the muriatic acid, calculated according to the above-described method, is required to thus effect the complete decomposition of a well-proportioned liquor. If it contains more hyposulphite than above indicated, less acid is, of course, to be used. About 90 per cent. of the sulphur contained in the liquor is precipitated in an almost pure state, and settles exceedingly well within two hours. The supernatant clear solution of chloride of calcium is then drawn off, and another operation directly commenced in the same vessel as soon as a sufficient quantity of sulphur is collected in it, which will depend on the size of the vessel and on the strength of the liquor, ranging from four per cent. to seven per cent. of sulphur; it is drawn out by means of a door at the lower part of the vessel into a wooden tank with a double floor, where the chloride of calcium is washed out by water, and the sulphur is then simply melted down in an iron pot. The product thus obtained contains only from one-tenth of one per cent. to one per cent. of impurities, and is thus by far superior to any sort of brimstone in the market, though it has sometimes a rather darker color, caused by traces of sulphide of iron, or a little coal dust, which latter may have been suspended in the muriatic acid.

The total yield of sulphur obtained by the process amounts thus to 10 or 11 per cent. of the weight of the salt-cake used in making black-ash, or to about one-half of the sulphur therein contained, and to about 60 per cent. of the sulphur contained in the waste. It is still hoped,

however, to considerably increase this quantity after some more years of experience.

The cost of production is inconsiderable. In the different continental and English works, where the process has now been working for years, the expense for wages, fuel, and maintenance amounts only to five dollars per ton of sulphur, and the outlay for the apparatus will be more than covered by the net profits of the first year. An establishment making three tons can save at least $2,000.

SULPHUR FROM COAL GAS.

In the manufacture of gas from coal, sulphide of hydrogen is one of the products from which the gas must be purified; and, for several years, what is known as the oxide of iron process has been adopted in large towns. This process consists in passing the gas through layers of peroxide of iron, mixed with some inert material to give it the necessary mechanical subdivision. The peroxide of iron is reduced to protoxide of iron, and the sulphur is precipitated in the mass, remaining uncombined. Exposure to air reconverts the protoxide into peroxide of iron without altering the sulphur contained in it; and this revived peroxide is used a second, third, and fourth time, in fact until the accumulated sulphur interferes with its rapid action, when it is replaced by fresh material. After repeated use this oxide of iron often contains as much as 40 per cent. of sulphur. Some sulphuric acid factories employ this residue thus charged with free sulphur, and manufacture sulphuric acid from it after certain cyanides are extracted from it by other factories. The amount of sulphur that could be thus furnished annually is very great, estimating the sulphur in coal as one per cent., when its average is actually much greater. In London and its suburbs alone the gas produced annually would furnish 15,000 tons, equal to 30,600 tons of sulphuric acid. M. Lawes, near London, uses 2,180 tons of this residue, each ton furnishing one and a quarter ton of sulphuric acid.

SULPHUR FROM CALIFORNIA.

To the northeast of Borax lake, in California, and about one mile from it on the borders of Clear lake, is a large deposit of sulphur, where solfataric action is still apparent. The amount of sulphur which has been deposited in this place is very large, covering an area of several acres, and extending to a depth not yet ascertained. From six to eight tons of this sulphur are refined daily, and are used in the manufacture of sulphuric acid, gunpowder, &c. A small quantity of cinnabar is associated with this sulphur. There is another large deposit two miles from this locality, at Chalk mountain, and still another at Sulphur Springs further east; but neither of them contain cinnabar. These and other localities of sulphur in California were represented in the collection sent from California by the commissioner.

PYRITES.

The manufacture of sulphuric acid from pyrites is probably the most important improvement made in manufacturing chemistry since the production of carbonate of soda from sulphate of soda, by Leblanc; and although it has been in operation for many years, it is instructive to review it in connection, together with the development of industrial chemistry in the past few years; for hardly fifteen or twenty years have elapsed since all sulphuric acid was manufactured from Sicilian sulphur, with but one or two insignificant exceptions, while now there is not more than one-tenth of this acid made directly from sulphur.

While the use of iron pyrites in the manufacture of sulphuric acid dates back prior to 1830, it was not until 1838 that the short-sighted policy of the king of Naples, granting the monopoly of Sicilian sulphur to Messrs. Taix & Co., of Marseilles, that its use was fairly established, for the price of sulphur rose in England from \$25 to \$70 dollars a ton, and in twelve months from that time, in England alone, not less than fifteen patents were granted for the manufacture of sulphuric acid from pyrites. And although the monopoly was soon withdrawn, by the persuasion of English vessels of war and the diplomacy of other governments, the pyrites had secured a firm footing in supplanting sulphur in the manufacture of sulphuric acid; and since then its use has rapidly increased, giving a wholesome lesson to governments to exercise great caution in granting monopolies and in legislating so as not to thwart industries based upon a science that draws colors rivaling the tints of the rainbow from coal, and that is not to be confined in the manner and method of its creations so long as the elements in one shape or another are at its command.

Since the first production of sulphuric acid from pyrites the establishment of Fahlun, in Sweden, has employed this process altogether, pyrites being very abundant in that locality. This example was followed by Perret, of Chessy, France, where the pyrites contains from three to four per cent. of copper, which metal can only be extracted by desulphurizing the ore. From the mines of this locality 70,000 tons of pyrites are burnt and exported annually, and the various lead chambers here for making sulphuric acid have a capacity of about 1,600,000 cubic feet. This process is carried on in all parts of France, whether the pyrites contains copper or not, and Sicilian sulphur is only employed for special purposes in France and England.

In the middle of France the pyrites of d'Alais is principally employed, it being very abundant. In the north of France the Belgian pyrites is used. In England the Irish pyrites is sometimes employed, although containing not more than 30 per cent. of sulphur; but most of the manufacturers use the pyrites coming from Huelva, in Portugal, containing 45 to 50 per cent. of sulphur, where the deposits of pyrites are remarkable for their great extent, extending into Andalusia, in Spain.

One of the mines that is worked in the province of Alemtejo, in Portugal, has a deposit of massive pyrites nearly a half a mile long by two hundred and fifty feet across the widest part, and contains from two and a half to four per cent. of copper.

Pyrites is frequently arsenical, and as the sulphuric acid produced from it contains arsenious acid, it is unfit for many purposes, especially where it is employed in the manufacture of products of domestic economy, such as acetic, citric, and tartaric acids, and also in some of the industrial arts, and in cleansing the surface of metals for alloying them with tin or other metal. In these cases acid made from sulphur is to be used, or the pyrites acid is to be purified by means of sulphide of barium or by sulphide of hydrogen, when the acid thus treated is equal in purity to any other.

It is not to be supposed, however, that sulphur is henceforth to be excluded from the manufacture of sulphuric acid; on the contrary, it is more than probable that many factories will return to its use, as the sulphur in Sicily is almost exhaustless, and if ever the country becomes opened to the world by good and numerous roads, the price of sulphur must diminish; and the diminution required is very small to bring it again into more common use among the acid manufacturers of the world. The factories in Belgium, in the north of France, and some in other parts of that country, those in Germany, and a number in England, will find it profitable in almost any state of the case to continue the use of pyrites.

III.—METHODS AND PROCESSES OF MANUFACTURE.

BURNING THE SULPHUR—SULPHUR FURNACES.

It is not necessary to dwell upon this part of the subject, from the fact that there are so many various ways, each said to be excellent, for securing the combustion of the sulphur used for the manufacture of acid. Reference will be made simply to the principles involved in the best form of furnace. It is better to have one large than many small furnaces, (called the sulphur furnace,) and to have all the sulphur used for one day's combustion (say from one to four tons) introduced at one charge, and to have just sufficient air admitted to keep up the combustion without heating the mass too much, as thereby more sulphur is volatilized. The vapor from the sulphur furnace should pass to the combustion furnace, in which sufficient air is admitted to complete the combustion, allowing an excess of about two to three per cent. of oxygen. From the combustion furnace the sulphurous acid therein formed passes to the nitre oven, and from thence the mixed vapors pass into the lead chambers.

LEAD CHAMBERS.

Too great care cannot be given to the construction and working of the sulphuric acid chambers. The plumbers should be required to distribute

the straps uniformly, and not to have too great a strain on any one, as the lead of the chamber is often torn by the neglect of this; the chambers should be kept in perfect repair and free from holes, or otherwise the sulphurous acid is lost in greater or less quantity. Where repairs are neglected, the practical yield with the same amount of material may range in three years from 82 to 68 per cent. of product.

The sulphur is not often lost from an incomplete conversion of the sulphurous into sulphuric acid by too little steam, too much air, and an insufficient quantity of nitre, but more frequently from too little chamber space to the amount of sulphur burnt. In connection with lead chambers it is interesting to refer to the chambers of Kuhlmann, of Lille, that prince of industrial chemists, the neatness and cleanliness of whose immense works is only excelled by the skill exercised and the purity of the articles manufactured. His chambers have a capacity of about 53,000 cubic feet. There are six different compartments, the first a small one, which is a cooler and purifier; the second a small denitrifying chamber; the third a small nitrification chamber; the fourth a large chamber; and fifth and sixth small chambers, called the tail chambers. Nitric acid is employed for oxidizing, which is introduced into the third chamber, in a small stream divided into a spray by convenient arrangements. The circulation of the liquid acid proceeds from chamber five, which opens into chamber six; from this it flows into the large chamber, which receives also the acid from the nitrification chamber; the acid collected in the large chamber ultimately passes into the denitrification chamber before it reaches the evaporating pans; to secure a perfectly regular distribution of steam through the whole system, the lead pipes which deliver it into the chambers are provided with platinum nozzles, which prevent the orifices of the tubes from gradually collapsing.

Some of the chambers in Lancashire have over 100,000 cubic feet capacity; and, as a general rule, the larger the chamber the better the proportional yield. One of the most important problems in the improvement of sulphuric acid chambers is to produce chambers of small dimensions capable of producing the greatest amount of sulphuric acid free from arsenic. To diminish the amount of capital in establishing a lead chamber for this acid, multiplies their number, and brings an article requiring a certain amount of useless water and bulky receivers nearer to the consumers, diminishing the cost of transportation.

At Bordeaux, Fournet has established the manufacture of sulphuric acid in a manner that deserves special attention, as it looks toward this economy just referred to. By means of apparatus skillfully arranged, in which the gas is made to circulate more than once in pipes filled with coke, so as to bring about an intimate mixture, and then passing it into a small lead chamber, Fournet has succeeded, with a chamber of only 12,000 cubic feet, in burning 1,000 pounds of sulphur a day and obtaining a yield of three tons of sulphuric acid, an amount nearly equal to the theoretical yield.

FURNACES FOR BURNING PYRITES.

There is nothing specially new in the present construction of furnaces used for burning pyrites, but as these are scarcely used in America, but perhaps can be with advantage, it is well to refer to them here.

At first fuel was mixed with the pyrites to keep up the combustion, but this was soon abandoned, and it is found that pyrites in burning furnishes all the heat necessary to continue the combustion. The beds of pyrites are made quite thick; at Javelle, France, they are made over three feet thick, and the doors of the furnace are luted. The combustion goes on very slowly, so that forty-eight hours are required for the upper layer of the pyrites to descend to the grate-bars. In this way most complete combustion is procured, and hardly two or three per cent. of sulphur remain in the residue. However, to accomplish this complete combustion, the pyrites must be in lumps; but as the pyrites is obtained about 10 per cent. of it is more or less pulverized, constituting one of the annoyances in this method of making sulphuric acid.

Various methods and furnaces are in use for the combustion of this fine pyrites, and they accomplish the result more or less perfectly.

The furnace of Spence, used almost universally at Manchester, is probably the best for this purpose. This furnace is a very long one, from forty to fifty feet long by six feet wide, and inclined about fifteen inches downwards. The floor of the furnace is of large flat tiles, and is heated from below by a lateral furnace three or four feet in advance of the lowest part. The fine pyrites is introduced by an opening in the top of the furnace, and is spread by means of rakes introduced through a lateral door only opened during the raking, and when it is necessary, by skillful movement, to push forward the pyrites to the lower part of the furnace. After being allowed to cool, it is drawn out of the furnace, at the front part, through an opening that supplies the requisite quantity of air by adjustment.

The roasting lasts about twenty-four hours—the furnace having twelve doors on the side, and two hours being allowed to the pyrites between each door before it is pushed forward. It is said that the fine pyrites can be made to give up all but two or three per cent. of its sulphur, a result not far from what is realized with that in lumps; and when it is remembered that this fine pyrites bears a less price than that in lumps, these results are certainly of vast importance to the large factories. Kuhlmann, in his process, mixes the fine pyrites with clay, and makes small balls or cakes, that, after drying, are used in the same furnace in which he burns the lump pyrites. Five per cent. of clay is sufficient to mix with the fine pyrites to form the little balls, and they can be made at a cost of about forty cents a ton in France.

The furnace that Michael Perret has introduced for burning fine pyrites in several establishments in France is highly spoken of. Instead of using the long furnace of Spence, he divides the furnace into a num-

ber of shelves, with large fire tiles, six centimeters thick and ten centimeters apart, and so placed in the masonry that the hot air and gases proceeding directly from the pyrites in lump, burning in the ordinary furnace, circulate back and forth (ascending all the time) over these shelves, on which the fine pyrites is spread to a depth of three centimeters. We may have ten or more of these shelves, until the furnace becomes inconveniently high. The operation lasts thirty-six hours, and each furnace can burn one ton of fine pyrites. This system is said to require one per cent. more of nitre in the subsequent operations.

FURNACE OF GERSTENHOFFER.

We cannot omit giving a passing notice of the furnace of Gerstenhoffer, of Freiberg, which is employed by the Vieille Montagne Company of France, and also at Swansea, in Wales. At the last-named place it is used for desulphurizing copper ores containing 30 per cent. of sulphur, and from which they are now collecting the sulphurous acid and making sulphuric acid.

The furnace is composed of a quadrangular tower eighty centimeters square and six meters high, closed at the top, except a long, narrow opening extending from one side to the other. Above this opening is placed a hopper of the same length, provided with two feed-rollers at the bottom, the movement of which feeds the furnace with pulverized pyrites. This pyrites, as it enters the furnace, falls on a triangular prism or cross-bar of brick fastened horizontally to the walls of the furnace, with its base uppermost. The powder gradually accumulates on this horizontal face, so as to make a pile with a triangular section, the base of which covers the face of the prism. After a short while the pyrites falls over on each side of the prism in two thin sheets, which, in descending, meet with two other prisms below so placed as to intercept it and cause it to accumulate again, and afterwards to fall over in four sheets, and so on. By successive descents over as many as twenty prisms the pyrites is brought thoroughly in contact with the heat and air of the furnace, and by the time it reaches the bottom there is not more than four or five per cent. of sulphur left in it. By openings, closed by movable stoppers in the side of the furnace, the process of oxidation of the pyrites can be seen, and the influx of air can be regulated.

UTILIZING THE RESIDUE FROM THE PYRITES FURNACE.

This residue, notwithstanding the little sulphur remaining in it, is used in the high furnace, mixed with ores for the production of iron. Mr. Bell, near Newcastle, and Perret in his operations, has shown that, by the addition of a little common salt in the desulphurizing process, iron of a good quality can be made from this material. When this waste product from the manufacture of sulphuric acid becomes useful in a remunerative industry, another great impulse is given to the production of this acid from pyrites.

COMBUSTION OF PYRITES COMPARED WITH THAT OF SULPHUR.

It is found, in making sulphuric acid from pyrites, that larger chambers are required, and a larger quantity of nitre in proportion to the sulphur burnt, than when sulphur is used. This arises from the higher temperature of the vapor from the pyrites, and from the greater quantity of inert gas that circulates through the apparatus. Too much attention cannot be given to diminishing the temperature of the gases, but in most works it is neglected; some, however, pass the gases through a kind of tubular boiler of lead surrounded by water, and thus cool down the vapors before they enter the chamber. Another precaution to be observed is, not to let the lump pyrites exceed the size of an egg, and to free it from fine matter that would clog the openings. There is very convenient machinery devised that will answer this purpose very well.

The little loss by the augmentation of inert gas in the chamber where pyrites is used may be diminished by determining, by frequent analyses, the proportion of sulphurous acid introduced into the chamber, a method now slowly growing into use; tests being made with a solution, *titrée*, of iodine, colored by starch. The gas is drawn from the chamber by means of an aspirator, and the water flowing from the aspirator is measured in a graduated vessel, which gives the bulk of the inert gases mixed with the sulphurous acid. This last is absorbed and calculated from the iodine solution through which the gases are made to pass. The mean of these analyses gives nine per cent. of sulphurous acid, which, according to the composition of the air and pyrites, ought to be mixed with 79 of nitrogen and 8½ of oxygen. This method of testing is well adapted to chambers where nitric acid is used or having nitrification furnaces constructed at the base of the chambers; but this testing can be used for all chambers at the exit, where the gases commonly contain six per cent. of oxygen. It would be well to diminish this quantity, taking care, however, that the oxygen does not disappear entirely, as this is a guarantee against the loss of binoxide of nitrogen, which is not absorbable by the cascade of sulphuric acid of Gay Lussac, when the proprietors of works are prudent enough to use his method of preventing loss of nitrous vapors.

Proper manipulation of the pyrites method depends on the nature of the combustion of the pyrites and the regulation of the draught of air. When the furnaces are well constructed with this in view, there can be obtained 126 parts of sulphuric acid for 100 parts of pyrites of 45 per cent. of sulphur, thereby utilizing as much as 42 per cent. of the sulphur. There is no greater drawback to this method of making sulphuric acid than the admission of too much air.

OXIDATION OF SULPHUROUS ACID BY NITROUS ACID VAPORS.

The compounds of nitrogen and oxygen are used as agents to complete the oxidation of the sulphurous acid by a reaction familiar to chemists. The introduction of the nitrous vapors into the lead chambers is carried on in several ways in Kuhlmann's large works at Lille, and in other factories in France a small stream of nitric acid is allowed to flow into the nitrification chamber, the size of the stream being regulated so as to furnish the proper proportion where it reacts on the sulphurous acid at a comparatively low temperature. It is a good process, and may be regarded as a more natural process than any other in supplying the nitrous vapors. The acid is allowed to enter into the first chamber in a small stream; it is made to strike on glass gutters, or a stone-ware vessel, in such a manner that the liquid acid is divided into spray. As this falls into the chamber, and comes in contact with the sulphurous acid, it only furnishes the useful nitrous products, there being no formation of protoxide of nitrogen, or nitrogen, as sometimes happens from a rapid action on the nitre pans, as when they are carelessly heated red-hot. The operation is very regular, and the economy in nitric acid more than compensates for the expense of first forming the nitric acid.

The more common process is by the action of sulphuric acid on nitrate of soda, and passing the vapors thus produced into the lead chambers. The method usually employed in England is the best for carrying out this decomposition, it being carried on in one instead of several vessels, and placing the vessel very near the entrance into the lead chambers. The quantity of nitrate of soda used by the several manufacturers for every 100 parts of sulphur, as stated by C. R. Wright, is:

For pyrites containing 45 to 50 per cent. sulphur.......	8.5 per cent.
For pyrites containing 30 to 50 per cent. sulphur.......	12.0 per cent.
For pyrites containing 35 average per cent. sulphur.....	12.5 per cent.
For pure sulphur.........	10.0 per cent.

EFFORTS TO PRODUCE SULPHURIC ACID WITHOUT THE AGENCY OF NITRIC ACID OR NITROUS VAPOR.

Several methods have been proposed, but no one of them has proved successful. Tennant Dunlap has approximated to success by a method which is in use, whereby having once produced the requisite supply of nitrous vapors no more are required except to make up the unavoidable loss. As this process is not familiar to most of our manufacturers, it will here be described, although it has been in successful operation for several years in the gigantic chemical works of C. Tennant & Co.

Instead of treating nitrate of soda with sulphuric acid, and employing the nitric acid thus obtained, a mixture of nitrate of soda and of chloride of sodium is decomposed, which yields, together with sulphate of soda, chlorine gas and nitrous acid. These gases are separated by passing them through concentrated sulphuric acid of not less than 1.75 sp. gr.,

when the nitrous acid is absorbed, the chlorine being utilized for the production of chloride of lime. The sulphuric solution of nitrous acid is allowed to flow into the chambers, where, by appropriate apparatus, it is brought into contact with water, which disengages the nitrous acid. At the works of Messrs. C. Tennant & Co., where this process is in use, they employ Gay Lussac's process for absorbing the nitrous acid from the escaped gases of the chambers, and M. Dunlap's process is used to such an extent as is found needful to provide for the waste of nitrous acid which occurs, notwithstanding the use of Gay Lussac's process. It will thus be seen that the immense quantity of sulphuric acid made by the Messrs. Tennant & Co. is formed without any nitrate of soda used specially for obtaining nitrous gas to be applied to the oxidation of sulphurous acid.

CONDENSATION OF NITROUS VAPORS BY GAY LUSSAC'S PROCESS.

The condensation of the excess of nitrous vapors that escape at the exit of the furnace in sulphuric acid works, by Gay Lussac's process, is very generally employed in France, but to a very small extent in England, where eight to ten parts of nitrate of soda are employed to every 100 parts of sulphur burnt. In all well-directed establishments this apparatus should be used to save the excess of nitrous vapors, and, while its use requires skill and care, it will reduce the quantity of nitrate required to less than two-thirds, and the saving will very much more than pay for the increase of expense and attention. This method has been long known, and is fully described in works on industrial chemistry, so that no detail of it need be given in this report.

PURIFICATION OF SULPHURIC ACID FROM ARSENIC.

The acid is sometimes boiled with a little common salt, and the arsenic goes off as terchloride of arsenic. But probably the most efficient and practical method is that adopted by Kuhlmann in his large acid chambers. The sulphurous acid from the combustion of the pyrites passes into a small chamber of 1,500 cubic feet capacity, that communicates with the furnace by a large leaden pipe forty or fifty feet long, sustained on its inside by iron bands covered with lead. In this way the sulphurous acid is cooled before it reaches the acid chambers, and several condensible products are deposited, among them the arsenious acid.

It is also purified by means of sulphide of barium, at Chessy, as it comes from the lead chamber, or by sulphuretted hydrogen; this last is successfully used at Freiberg in the following way: the apparatus used for making the sulphuretted hydrogen is composed of two large leaden vessels, placed side by side, and communicating with each other at the bottom. One of the vessels is filled with sulphide of iron and the other with diluted sulphuric acid. The gas as it is produced enters a long column full of coke, while the acid from the chamber is run through the coke by a kind of receptacle that alternately fills and empties itself,

thus giving an intermitting flow. As the acid has time to spread over the coke, the sulphydric acid and the arsenious acid react on each other. The flow of gas is regulated according to the quantity of arsenic present. The acid thus acted on falls into a leaden receptacle, is allowed to settle before it is concentrated in the lead pans, and, finally, in the platinum still.

The separation and purification from nitrous acid, when the sulphuric acid contains it, can be effected by adding either a little sulphate of ammonia or alcohol in the lead pans used in the first concentration.

CONCENTRATION OF SULPHURIC ACID.

It is well known that the acid as it comes from the lead chambers is first concentrated in lead pans. Little or no improvement has been made in this part of the concentration. In these pans the acid can only be brought to a degree of concentration equal to 1.70 sp. gr. Further concentration is carried on in glass or in platinum vessels.

The high price of platinum, and its monopoly by the Russian government, from which it gets into the hands of a few manufacturers, has driven many of the makers of sulphuric acid to return to the use of glass which they had once abandoned. In addition to this there has been considerable improvement in the manufacture of large lead-glass vessels, so that now about four-fifths of the acid made in England and Belgium is concentrated in glass, of which the original price and breakage, &c., does not exceed half of the annual interest of the cost of platinum stills. The vessels are very large, and are heated in open fire, or in iron pots, with a thin layer of sand between them and the sides of the pots. The vessels are kept constantly at work. The acid is drawn off by a siphon, and the vessels are immediately refilled with hot acid. The temperature of the room must be kept very warm, and a proper provision should be made for carrying off the vapors. The heat and the presence of the vapors of acid are very injurious to the workmen, and they suffer more or less from them. In this way, in South Lancaster alone, 700 tons of sulphuric acid of 1.85 sp. gr. are manufactured weekly.

In France platinum stills are almost altogether used, and the manufacturers of these vessels have exercised their ingenuity to diminish their cost, and none of them have succeeded so well in this direction as Messrs. Johnson & Matthey, of Hatton Garden, London. In 1862, in London, they exposed a still capable of concentrating from two to four tons of acid in twenty-four hours, for not much more than twenty-five per cent. of the former prices. The apparatus cost $2,300. In 1867, when I visited their establishment, they were actively engaged in the manufacture of platinum stills, making some with the neck of the still directed upwards, to prevent the violent boiling of the acid from throwing over portions of concentrated acid. The form of one of their stills, its dimensions, and the shape of the upturned neck, are shown upon Plate VII, Fig. 1. The platinum stills exhibited coming from the establishments of Desmontes,

Chapins, and Quennessen, in Paris; Herasus, of Hanau; and Johnson and Matthey, of London, were most beautifully executed. In soldering all of these makers use gold, except the last-mentioned firm, who burn the sheets of the metal together at the seams and joints with the oxy-hydrogen blowpipe, and for large vessels of platinum the last-mentioned manufacturers turn out work more to my satisfaction than any of the others.

It is not usually understood that while platinum is not virtually acted on by sulphuric acid it does experience a little and gradual loss of substance by the action of the acid, and this especially when it contains nitrous acid, but this last can be prevented by adding a little sulphate of ammonia prior to distilling. Even when this precaution is taken there is still a loss, less in new and more in old vessels, commencing with a loss of one gram and gradually increasing to two grams for every ton of acid concentrated. When the platinum contains iridium the loss is diminished 50 per cent., but the Paris manufacturers, I believe are the only ones who have used iridium in their platinum, and they do not do it except by express order, for platinum that contains it is more difficult to work.

With this I will terminate the brief review of the present condition of the manutacture of sulphuric acid in the world, as brought out by the Exposition of 1867, and by the examination of old and well established factories.

A complete set of working drawings for model sulphuric acid works is appended. Full explanations and details will be found on the plates and in the explanatory pages accompanying them at the end of the report.

CHAPTER II.

SODA AND SALTS OF SODA.

PRINCIPAL SOURCES OF SODA AND ITS SALTS—WIDE AND GENERAL DISTRIBUTION OF SODA AND ITS COMPOUNDS—THE PROCESS OF LEBLANC; ITS IMPORTANCE AND PERFECTION—SULPHATE OF SODA; ITS MANUFACTURE AND USES—SULPHATE OF SODA FROM THE MOTHER WATER OF SALINES—OTHER SOURCES OF SODA—THE MANUFACTURE OF SODA FROM SALT—SULPHATE OF SODA FROM SALT—MAKING BLACK-ASH—EXTRACTION OF THE CAUSTIC SODA—THEORY OF THE PROCESS—MANUFACTURE OF SODA AND CARBONATE OF SODA FROM CRYOLITE—CRYOLITE AND ITS SOURCE—DECOMPOSITION OF CRYOLITE—PURE SODA MANUFACTURED FROM THE METAL—BISULPHITE OF SODA—HYPOSULPHITE OF SODA.

PRINCIPAL SOURCES OF SODA AND ITS SALTS.

It is unnecessary in this place to detail facts upon the manufacture of soda and its salts familiar to chemists and to be found in all works on technical chemistry. Mention will only be made of the more striking results developed during the past few years, especially as exemplified by the Exposition. We purpose to notice the most important of the compounds of soda used in the industrial arts, and whatever may be thought necessary to detail in relation to their manufacture, statistics, &c. There is no substance so well known or so universally in the hands of all as that of soda, either in the form of sal soda and bicarbonate of soda, or in combination forming soap and glass. As the production of sulphuric acid from pyrites was caused by restrictions placed around the introduction of sulphur into various countries, so the present process of manufacturing soda was developed by a similar restriction, but from a different cause. The war in which France was involved in the latter part of the last century created a great scarcity of soda in France. It was imported principally from Spain, where it was made from sea-weed, and by this scarcity attention was drawn to the process of Leblanc, then recently discovered. The first city in France in which the manufacture was established, viz., Marseilles, is still largely engaged in its production, as well as in the manufacture of its natural offspring, soap.

PROCESS OF LEBLANC—SODA FROM SALT.

It is certainly in place here to refer to the origin and history of the great discovery by Leblanc, and in doing this I will use the words of Hofmann and of Ward in writing on this subject.

The ever memorable discovery, by the illustrious Leblanc, of the process now everywhere in use for manufacturing carbonate of soda from

common salt, stands distinguished in the annals of industry, not only as by far the most important of all chemico-industrial inventions, but also (a signal fact) of having been created perfect. All the other great chemical industries have been slowly worked out by the toil of successive inventors, but Leblanc's process, the greatest of them all, remains to this day what it was when he first gave it to the world, the best and simplest method of effecting the most valuable of all known transformations. Though eighty-six years have elapsed since this splendid discovery was made, and innumerable researches have been undertaken with a view to its improvement, the original indications of Leblanc are all but universally followed, with merely a few comparatively unimportant modifications.

It might have been expected that a process which, at its first introduction, was examined by a government commission of thoroughly practical men, and which, after having been submitted to comparative experiments, made with the greatest care, was recommended in an elaborate official report, would have been almost immediately adopted throughout Europe, with proportionate advantage to its discoverer. Such reasonable hopes, if entertained by Leblanc, were destined to cruel disappointment. Leblanc himself never reaped the reward of his admirable discovery. This man, who was certainly one of the great benefactors of his race, and to whom, long since, France and England should have joined to raise a statue, lived in poverty and died in despair. The creator of incalculable wealth for his species, he wanted bread himself; and, after endowing man with cheap soda—that is, with the inestimable blessings of cheap glass and soap, cheap light and cleanliness, and a hundred collateral advantages—he was suffered, to the shame of Europe, to end his days in a hospital. There he lingered, a wreck in fortune, health, and hope, till reason herself gave way at last, and he perished madly by his own hand. It is to be hoped that with the advance of civilization these terrible tragedies, so frequent in past ages, will become more and more rare, till the future historians of progress shall be spared the pain and shame of recording any more such outrages on justice—such ghastly martyrdoms of genius.

SULPHATE OF SODA.

More than six-tenths of the sulphuric acid manufactured is used in the manufacture of the soda salts. The old method of making sulphate of soda by acting on common salt with sulphuric acid is universally adopted. A fact worthy of note in regard to this salt is, that the French sulphate is much purer than that made in England, which must be owing to the more careful manipulation by the French manufacturers. The French sulphate is of remarkable whiteness, as I have seen in the factory of Kuhlmann at Lille; the sulphate manufactured there is largely used in Belgium and France for making the finest plate glass. A process of making the sulphate was at one time employed near Liverpool by mixing iron pyrites and salt; the result of the reaction being volatile ses-

quichloride of iron and sulphate of soda, which last was separated b the aid of hot water.

The principal use of sulphate of soda is to manufacture the carbona by the process of Leblanc, which, although over eighty years old, h never been supplanted by any other.

SULPHATE OF SODA FROM THE MOTHER WATER OF SALINES.

In France and Germany the mother waters of the salines are worke to extract the salts that they contain, and by the process of Balar By using carefully regulated temperatures, these salts are crystalize out. The sulphate of soda may be obtained in this manner, but as thi salt made by the direct action of sulphuric acid on common salt i obtained more cheaply, the process is not much resorted to. The prin cipal object of treating these mother waters is to extract the potash salts.

SODA FROM CRYOLITE AND FROM SODIUM.

Soda is now largely obtained from cryolite, an interesting mineral which occurs in abundance in Greenland, and it is also prepared to a limited extent from the metal. These two sources will be considered at length after some details upon the manufacture of soda by the process of Leblanc have been given.

MANUFACTURE OF SODA FROM SALT.

This resolves itself essentially into four operations:

1. Formation of sulphate of soda by decomposing common salt.
2. Heating the sulphate of soda mixed with lime and charcoal in a furnace to form what is called black-ball.
3. Lixiviation of the black-ball with water to extract the alkaline products.
4. To obtain caustic soda and carbonate of soda by proper evaporation and concentration of the liquor.

THE FORMATION OF SULPHATE OF SODA.

There are two methods by which sulphate of soda is produced—namely, in the moist way in leaden vessels, and by the dry way in fur- naces. The former is employed to a very large extent, and must always be used where a pure white sulphate of soda is required. M. Kuhl- mann, at Lille, manufactures a large quantity of this description of sulphate which is afterwards heated in hot chambers and all its water of crystallization driven out, forming a pulverulent mass as white as the driven snow, and used largely by the glass makers, which could not be done if the decomposition of the salt was conducted in iron vessels. The more common form in England of decomposing the salt in a furnace of a peculiar construction is fast coming into use everywhere where the sulphate only is used for the subsequent operation of transforming it

into carbonate. The process most generally adopted will be described particularly, as it affords a very complete condensation of the hydrochloric acid formed, so much so that the use of this process in Belgium is compelled by law. An account of the furnace as constructed and used in the works of Tennant & Co. has been given by Professor Hofmann, and I use his own words in describing it.

As this apparatus is now generally arranged, it consists of a muffle constructed of cast iron, and a second muffle constructed of brick work. The lower part of the iron muffle represents the segment of a hollow sphere, made of thick cast iron, nine feet in diameter in its widest part, and one foot and nine inches in depth. This is placed on a seating of brick work, and is surmounted with a cover of cast iron, also the segment of a hollow sphere, about one foot deep in the center. This cover has two doors, through one of which the salt is introduced, while through the other the mixture can be passed into the brick muffle. A fireplace is arranged beside the iron muffle, and a flame is passed firstly over the iron cover and subsequently under the iron pan. The requisite heat is thus given to the contents of the muffle by transmission, and the gas is evolved at a comparatively low temperature unmixed with air. The brick muffle is adjacent to the iron one, both being seated on the same pile of brick work, and having flues which communicate with each other. The brick muffle consists of a chamber about thirty feet long and nine feet wide, having a floor constructed of bricks, which forms the covering of a number of flues; the upper part of this muffle is formed by a thin arch of brick work, which is again surmounted by a brick arch, a flue being thus formed between the two arches. A fireplace is arranged at one end of the brick muffle, the flame of which is first caused to traverse the flue between the two arches of the muffle and then to return through the flues under the brick floor. Heat is thus applied to the contents of the muffle by transmission through the brick work of its arch and floor.

In using this apparatus, half a ton of salt is thrown into the heated iron muffle, and the requisite quantity of sulphuric acid, of about 1.7, is run upon the salt. The mixture is assisted by the use of the iron rake, and a strong effervescence of hydrochloric acid ensues. The mixture generally thickens, and at the expiration of about one hour and a half, (when about two-thirds of the hydrochloric acid has been driven off,) it becomes pasty and ready to be transferred to the brick muffle. This is effected by pushing the pasty mixture through the channel of communication between the two muffles. To complete the expulsion of the hydrochloric acid, it is needful to maintain a red-heat in the brick muffle. A provision is made for closing the communication between the two muffles, so as to have the power of keeping separate the gases proceeding from each, as the gas from the brick muffle will furnish a more concentrated acid, by condensation.

The acid gas that escapes from this furnace is condensed by one of

the methods described under the head of hydrochloric acid. Furnaces of the above description have been in use in the works of Tennant, at Glasgow, for twenty years, decomposing 500 tons of salt weekly, and with the most perfect success, and no annoyance to the neighborhood by acid vapors.

MAKING BLACK-ASH.

The second process consists in mixing sulphate of soda with lime and heating it in a furnace. The proportion of these ingredients is not the same in all manufactories; they vary nearly as follows at different places: Sulphate of soda, 100 parts; carbonate of lime, from 121 to 90 parts; coal, from 71 to 35 parts.

These differences arise from the difference in the purity of the materials, some using anthracite coal giving 80 per cent. of solid carbon, others using coal giving only 60 per cent. of carbon, and 10 to 18 per cent. of ash.

Kuhlmann, who uses a coal leaving about four or five per cent. of ash, employs sulphate of soda and carbonate of lime, 100 parts of each, and 37.7 parts of coal.

The three ingredients above mentioned are placed in furnaces of different descriptions, fully described in works on technical chemistry; the materials are not pulverized, the coal and lime being both thrown in in lumps, as the method of manipulation renders the finished material easier of lixiviation in the next operation.

The only furnace that may be considered as an innovation of the older one, is the English revolving furnace. It has been employed since 1861, and although there was a disposition at first to condemn it, it has gradually grown into favor and will doubtless soon find its way into France and other continental countries. Mr. Stevenson describes one of those first erected as follows: It consists of a horizontal cast-iron cylinder, eleven feet long, and seven and a half in diameter, lined with nine-inch brick work. Two circular openings, about two feet in diameter, in the ends, allow the flame from the furnace to pass through the cylinder and over its contents. The cylinder rests on four rollers, one pair of which is turned by machinery, so as to cause the cylinder to revolve. The charge is introduced from a hopper above, through a door in the middle of the cylinder, and the charge runs out at the same door when the decomposition is completed, the cylinder being stopped for this purpose, with the door downwards. No tools being required to turn over the materials, the furnace can be kept closed, its brick lining lasts a long time, and the saving of manual labor is considerable. A revolving furnace of the dimensions given above decomposes 1,400 weight of sulphate of soda every ten hours, at the cost of 43 cents per ton, including wheeling and charging the materials.

This furnace is heated by the products of combustion passing through it from end to end, there being a fireplace at one end of the apparatus and a chimney at the other. At the present time the dimensions of these

are made even larger; some of them are seventeen feet long by twelve feet in diameter, into which the carbonate of lime is first introduced in large fragments and the cylinder put in motion slowly, then the sulphate of soda and coal are added, and the motion is accelerated. In such a furnace three tons of matter can be treated at one time. A very active combustion is kept up in the furnace, so that there may be heated flame in the whole length of the cylinder; the excess of heat is not lost, but is used for the evaporating pans, &c. "Black-ash" is the name given to the material as it comes from the furnace, and it is usually made up into balls while still hot. A good deal of this ash is sold at once to the soap makers, but most of it is lixiviated, and from the solution soda-ash, crystallized soda, and caustic soda are made. As there is no improvement in the beautiful method long employed in England and elsewhere for lixiviation, and which is said to be due to Mr. James Shanks, of St. Helens, we will not give any details on this subject, but refer those desiring further information to the excellent description of the method to be found in various books. The grand result aimed at and accomplished is the complete washing out of all soda from the black-ash with the least quantity of water.

The black-ash compound consists essentially of carbonate of soda and sulphide of calcium, but then there are various other substances in small quantities arising from impurities in the ingredients or from imperfect decomposition. When treated with water this compound yields considerable caustic soda; this, however, is not supposed to be in the ash, but to be produced by the action of water in the presence of the oxysulphide of lime that is converted into carbonate of lime and sulphide of calcium.

CAUSTIC SODA FROM BLACK-ASH.

It has been stated that some of the carbonate of soda formed in the furnace operation is converted into caustic soda by the treatment of the ash with water. Formerly it was the habit either to dry the mixed soda mass and send it to market as soda ash, or to convert it into carbonate of soda and crystallize it as soda crystals, but for several years much of this soda has been sold as caustic soda, especially since the adoption of Gossage's process of separating the caustic soda simply by a judicious process of evaporation. Although this method has been employed for some time on an extensive scale, it is thought advisable to give a condensed description of it from the Exposition report for 1862, particularly as time has approved its value. The crude liquors obtained by exhausting black-ash are evaporated to a considerable degree of concentration, so as to separate a greater part of the carbonate, sulphate, and chloride of sodium. When the liquor has been brought to a specific gravity of 1.5 nearly all the foreign salts are deposited, and there remains in solution caustic soda, a peculiar red compound of sulphide of iron, (which has procured for these solutions the name of red liquors,) together with small quantities of carbonate, sulphate, chloride, ferrocyanide, and some-

times sulphocyanide of sodium. Chloride of lime or nitrate of soda is now added to oxidize the sulphide, and after concentration to 1.6 specific gravity, at which time more salt is deposited and raked off, it is run into settling vessels and again placed in the evaporators and concentrated and kept for some time in a state of igneous fusion when further deposits take place, and when it is concentrated so as to contain about sixty per cent. of anhydrous soda, it is run into sheet-iron vessels with the joints made tight by gypsum. It is closed up firmly and perfectly and then delivered to commerce, and is used by the paper-maker, soap-maker and others.

THEORY OF THE MANUFACTURE OF SODA BY LEBLANC'S PROCESS.

Notwithstanding more than eighty years have elapsed since the manufacture of soda by this process, it is only since 1862 that anything like a clear solution of the problem has been propagated—one which seems to have very nearly cleared up all difficulties connected with its explanation.

In the furnace the first change takes place, at a comparatively moderate temperature, when the sulphate of soda is converted into sulphide of sodium. At a higher temperature a reaction takes place between the sulphide of sodium and carbonate of lime, when carbonate of soda and sulphide of calcium are formed, with the escape of carbonic acid; which sulphide of calcium was formerly thought to be soluble, but the insolubility of it when made by fusion is now clearly established. This reaction can be accomplished with an atom each of sulphate of soda and carbonate of lime, with the necessary amount of coal for the deoxidation; but most commonly an excess of lime is added to furnish a larger surface to the fused sulphide of sodium. In order to accomplish more readily the decomposition of the sulphide, an excess of coal is added to increase the temperature of the mass, and it also contributes at the end of the decomposition to transform the excess of carbonate of lime into caustic lime, and when this takes place (and at no other time) carbonic oxide is given off, the escape of which gas is an indication that the operation is at an end; the porosity of the pasty mass, so useful in the subsequent operation, is brought about by the escape of this last mentioned gas.

This mass which constitutes the black-ash undergoes new decompositions when brought in contact with the water required to extract the carbonate of soda. In the first action of the water it is found to contain besides the carbonate of soda only traces of caustic soda and sulphide of sodium; but as the action of the water is continued and time is given for the caustic lime to become hydrated, the quantities of the caustic soda and sulphide of sodium increase with a proportional diminution of the carbonate of soda.

The above may now be considered as the true nature of the changes that go on in the making of carbonate of soda from sulphate of soda.

If the water used in treating the black ash in the vats generally adopted for some time be evaporated and the dry mass treated in the

soda furnace so as to oxidize the sulphide of sodium, we obtain the ordinary soda-ash, composed of carbonate of soda, caustic soda, and sulphate of soda; this is productive of some loss, so that another method has been adopted for many years by which the soda value of the ash is increased. In treating the black-ash with water, the first portion of the water is strongly saturated with soda-salt and caustic soda, containing hardly a trace of sulphide; this portion is evaporated separately and dried, furnishing a salt almost pure; the last portion of water with which black-ash is treated is a dilute solution of the salts with considerable sulphide of sodium. This solution is treated with carbonic acid, which combines with the caustic soda and decomposes the sulphide. This last solution is now evaporated to dryness and furnishes quite a pure carbonate of soda. A still further improvement by Mr. Gossage has been made within the last ten years in the treatment of the solutions for the purpose of furnishing commercial caustic soda, an account of which has been already detailed.

MANUFACTURE OF SODA AND CARBONATE OF SODA FROM CRYOLITE.

Many and vain have been the attempts to supersede the process of Leblanc for the production of soda, and vast amounts of ingenuity and capital have been expended without success. But this statement does not apply to the production of soda, to a limited extent, out of a curious mineral found in Greenland called cryolite. This mineral was exhibited in abundance at the Exposition, and as there is an important manufacture of soda from it established at Natrona, Pennsylvania, the details of the method employed will be briefly described. These details have been kindly furnished to me by J. A. Hagemann, the chemist of the Danish Cryolite Mining Company, who directs at this time the manufacture of soda from cryolite by the Pennsylvania Salt Manufacturing Company. We may look for the best information on the subject to the above named company's works, which are imitations on a large scale of the factory built by Julius Thomsen, of Copenhagen, in 1856. Some information has also been obtained from an essay by Sam. F. Simes.

CRYOLITE AND ITS SOURCE.

Before proceeding to a description of the process of manufacture it is well to give some short account of this mineral and its present commercial movement.

The mineral cryolite, or "ice-stone," has been known as a mineralogical rarity for many years, as far back as the latter part of the last century; thirty years ago it was worth fully a dollar an ounce, and it was considered only as a rare and curious mineral, of no value in the arts. Up to 1850 no attempt had been made to put it to any practical use, although

it was known to exist in Greenland in large quantities and to contain a large amount of soda, for its composition is—

3 Sodium	69
2 Aluminium	27.26
6 Fluorine	114
	210.26

It has a specific gravity of 2.95 with a hardness of 2.05. Much of it is found colorless and pure. The associate minerals are galena, blende, spathic iron ore, iron pyrites, and copper pyrites.

With the exception of some few scattered specimens that occur at Miask, in the Ural mountains, it is found exclusively in Greenland, and in immense quantity. It is procured from the mines of Ivigtout on the west shore of South Greenland, on Arsuk Fiord, between Julian's Hope and Frederick's, latitude 61° north, longitude 48° west. The main deposit here forms a mass six hundred feet in length and two hundred feet in width, and descending to an unknown depth. It lies at the base of granite hills, that rise a little distance from the edge of the Fiord, the shores of which are very bold and are almost fathomless a few feet from the shore.

The Danish government is the owner of this mine, and in 1864 Christian IX granted the exclusive right of mining cryolite to the "Cryolite Mining Company of Handelselhabet," a company organized in Copenhagen. This contract was made by a Danish company in consequence of the results of the labors of a young Danish chemist, Julius Thomsen, in 1850, who discovered a cheap and easy method of rendering cryolite available in technical chemistry for the manufacture of soda and alum, and his process is carried on in Europe and this country on such a scale as to consume annually twelve to fifteen thousand tons of cryolite.

PROCESS OF DECOMPOSING CRYOLITE.

Thomsen's process of decomposing cryolite is simply by lime, either in the wet or dry way. The decomposition may be represented by the following formula:

$$2\,(Al_2\,Fl_3 + 3\,Na\,Fl + 6\,Ca\,O) = 3\,Na\,O + 2\,Al_2O_3\,3\,Na\,O + 12\,Fl\,Ca.$$

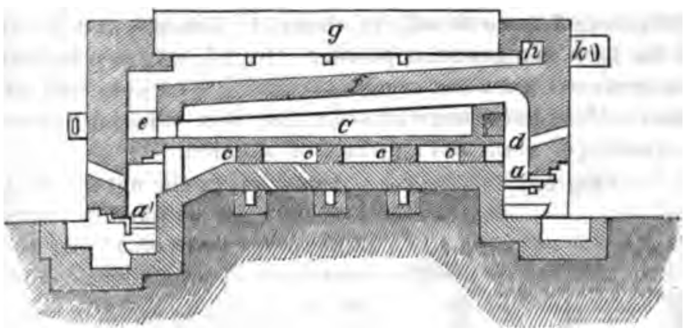
Another method is to calcine finely powdered cryolite and mix it with six equivalents of lime; the product will be "caustic soda, aluminate of soda, and fluoride of calcium." Another is to boil cryolite with the same proportion of lime in the form of milk of lime, and a similar decomposition takes place. The soda and aluminate are soluble in water; the latter is subsequently decomposed by carbonic acid. Both the wet and dry process will now be described.

THE DRY PROCESS.—The cryolite is dried in a furnace, and by a crusher is reduced to small fragments, which are ground in a burrstone mill to a fine powder, and uniformity in the powder is insured by passing it through a bolter of fine wire gauze. The powder is then mixed with slacked lime, or with pulverized chalk, in proportion to its purity.

ıat for each equivalent of pure cryolite there shall be a little more ı six equivalents of lime. This mixture is effected on chaser mills, ı as are used for crushing linseed and other oily grains. This mix- is now calcined, and here arises the great difficulty of the process, he soda or carbonate of soda and the fluoride of calcium fuse at a temperature, and if allowed to fuse would almost entirely prevent subsequent lixiviation with water. Care must therefore be taken to 'ent the temperature from rising high enough to fuse the mass, while he same time the mass must be heated sufficiently to effect the ɩmposition.

'hen the factory at Copenhagen was erected in 1856, this decompo- n was effected in iron retorts similar to gas retorts and set in the e way, and the carbonic acid so liberated (when chalk was used) was lucted to the vats to decompose the aluminate of soda from a previ- operation. But this process entailed costly repairs and much ɩnsive handling. Thomsen then constructed a furnace which is now essfully used in all the cryolite factories.

Fig. 1.



Furnace for decomposing Cryolite.

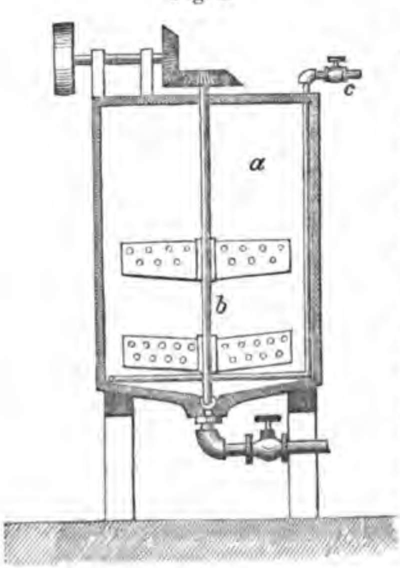
g. 1 is a sketch of this furnace one hundredth of its size. *a a'* are fire-places. The flame from *a* passes underneath the hearth C, which rmed of large slabs of fire-clay two feet square, and supported on ıre pillars *c c c*. At *d* the flame from *a* meets the flame from *a'* and ı pass over the hearth, when, arriving at *e*, they rise up and pass · the arch *f*, and thereby give off the last portions of heat to the ɩorating-pan *g*, and, finally, at *h*, they pass into the flue of the chim- having a damper, *k*, to regulate the heat.

ıe mixture is spread on the hearth about three inches thick, and is disturbed for about one hour, at which time it is turned over with a and again left for about three-quarters of an hour, after which it is ɾn out and fresh material is introduced, each charge being about) pounds. The decomposition should be complete in the portion drawn, and it forms a granular, loose mass of an ash color. After mass has thoroughly cooled it is lixiviated in an ordinary tank, and

da and aluminate of soda is drawn off, and the residue washed. The solution will, on an average, mark 26° to 28°

a strong solution of soda, carbonate of soda, and alumi, is treated with carbonic acid in order to produce carbonate of soda and alumina. The carbonic acid is produced by the combustion of coke, and the products of combustion are drawn off by means of a fan, and passed through stacks filled with coke, down which water is made to trickle; and in this way the carbonic acid is washed and purified. The purified gas is passed from these stacks into a large ontal cylinder, from 40 to 50 feet long, through the middle of which shaft with paddles rotates. The cylinder is about half filled with liquor, the paddles are put in motion, and the gas is let on through one end of the cylinder, the unabsorbed gases escaping at the other end. When the solution is saturated with carbonic acid it is run off into settling-boxes capable of holding one charge. In about from four to six hours the alumina will have separated from the liquor which is drawn off, and the deposited alumina is freed from the adhering soda by washing it with water and filtering upon proper filters. The clear solution first drawn off has a density of about 31° Beaumé, and the alumina is left in the form of a granular powder. In this way two valuable products are produced from the cryolite—carbonate of soda and alumina. The latter contains but a trace of soda, and is a valuable material for the manufacture of alum and sulphate of alumina.

Fig. 2.



Apparatus used for the decomposition of Cryolite in the wet way.

Considering the nature of the mineral and its impurities, sometimes amounting to 10 or 15 per cent., the carbonate of soda is remarkably pure, its only impurity being one or two per cent. of sulphate of soda, the sulphuric acid having been formed from the sulphides that are associated with the cryolite.

THE WET PROCESS.—If cryolite be boiled with six equivalents of lime, the decomposition which takes place is similar to what occurs in the dry process; but if two equivalents of cryolite be boiled with 15 equivalents of lime, the resulting product will be caustic soda, aluminate of lime, and fluoride of calcium.

$$2\,(Al_2\,Fl_3 + 3\,Na\,Fl) + 15\,Ca\,O = 6\,Na\,O + 2\,Al_2\,O_3\,3\,Ca\,O + 12\,Fl\,Ca.$$

In either case the decomposition is effected as follows: Into a large vertical cylinder, *a*, Fig. 2, scale $\frac{1}{100}$, pro

vided with a perpendicular shaft having paddles, *b*, and a steam-pipe, *c*, ending close to the bottom in a perforated ring, is introduced milk of lime, made from about 15,000 pounds of good lime. The paddles are now put in motion, and the mass is agitated for a little time, and the liquid is then assayed and measured, so as to ascertain the exact amount of lime present. The cryolite is then added in fine powder in the proportion desired to accomplish a given result. Two equivalents of cryolite and 12 equivalents of lime will produce, as already stated, caustic soda and aluminate of soda. Fifteen equivalents of lime will furnish all the soda as caustic soda, with aluminate of lime. Fluoride of calcium is formed in both cases.

After two or three hours' boiling and agitation the decomposition is generally completed, (testing will indicate the liberation of all the soda,) and the contents of the agitator are discharged on a suitable filter. The clean liquor which will form on top of the sediment is drawn off, and the sediment is treated with water as long as the filtered liquid contains soda.

If the first proportion of lime has been used and aluminate of soda has been formed, the liquid is treated with carbonic acid, as in the dry process, and all the soda is converted into carbonate, and the alumina is deposited as an insoluble residue. If the latter proportion of lime is used, and all the soda be in the solution as caustic soda, all that it is necessary to do is to evaporate the liquid to dryness in pans or kettles. In this manner caustic soda containing 75 per cent. of NaO is manufactured on a very large scale at Natrona.

It is evident that the wet process is decidedly the simpler of the two, there being less handling and less costly apparatus; but the feeble strength of the lye produced (10°B) by this process, and consequently the large amount of water to be evaporated, is a great drawback to it. Where alumina is of but little value and caustic soda is much sought after, the wet process with 15 equivalents of lime may be most profitably employed. Where the contrary is the case, the dry process is to be preferred, producing a lye of 26° to 28°B, and requiring but little concentration in order to crystallize.

Besides working out all the details of this process, Julius Thomsen has devised volumetric processes of analysis adapted to different stages of the operation. Weber & Bro., of Copenhagen, not only furnished all the means necessary for conducting his experiments, but established a factory in Copenhagen and sent vessels to Greenland for the cryolite. Their factory has been the model on which others have been erected.

There are four establishments in Germany, consuming annually about 2,000 tons of cryolite; and in 1867 the one in this country was erected by the Pennsylvania Salt Manufacturing Company, having a capacity for working up about 6,000 tons of cryolite. This company, in 1867, imported 8,000 tons, and sent out to Greenland during the summer 19 vessels of an average capacity of 450 tons, of which two were lost in the ice. The approach to the coast is considered dangerous on account of

the of ice, which sometimes form a thick and impenetrable belt of 80 to miles in width. Off the western coast of Greenland the wind scatters the ice, and a good navigator can penetrate the openings without delay. No loss of life has yet occurred in this trade, as the ice affords a refuge for a shipwrecked crew until removed by the Esquimaux or until they escape by their boats to the settlements. The mines are worked, from May to October, by about 150 men. In the salt works of Natrona, Pennsylvania, more than half a million of dollars have been invested, and employment has been given to 500 men. The alumina manufactured there in connection with the soda is supplied to the largest makers of alum in this country; but this will be referred to again under alumina. The various manufactures from cryolite have a market value of over $1,000,000 in gold.

There has been no important improvement on Thomsen's processes, except it be one by G. A. Hagemann, on which a patent has just been obtained.

Beauxite (a mineral containing 80 per cent. of alumina) is sometimes mixed with the cryolite to increase the yield of alumina, and this process will be referred to under the part of the report relating to alumina.

Much space has here been devoted to this manufacture of cryolite soda, from the fact that cryolite and its products were conspicuous in the Exposition, and that the value of cryolite and its treatment as a soda-yielding substance, is but little understood and appreciated by technical chemists generally.

PURE SODA FROM SODIUM.

One of the most curious triumphs of modern chemistry is the production of *pure soda* from the metal sodium at a price cheaper than the same article can be made by any other process previously adopted. It was made and exhibited by the firm of Messrs. Johnson & Matthey, of London. The bars of sodium, as they are now made by several European chemists, after the method of Deville, are cut into fragments of about a cubic inch in size. One of these fragments is thrown into a silver dish, floating on a stream of cold water; a little distilled water is poured on the sodium, and the vessel is agitated by the hand, which prevents explosions. After the first lump is dissolved another lump is thrown into the silver capsule and treated in the same way; and so on successive lumps are added. After a deposit of soda forms at the bottom and on the sides of the vessel the tendency to explode diminishes, but it is important to keep the vessel agitated to prevent the burning sodium from being scattered. The solution is somewhat milky, and must be filtered and evaporated, and then fused in a silver capsule or crucible, until the moisture is driven off and the mass is transparent; it requires a dull-red heat for this purpose. It is removed from the crucible while hot, broken up, and put in well stopped bottles. The operation is a slow one, and is disagreeable from the odor of the vapors and the danger of explosion. A steady

workman can treat in this way one and a half pound of sodium, or, with two dishes, two pounds of sodium. Pure soda is thus made and sold for $1 75 in gold per pound, including bottle and packing case, the metal sodium being sold by the same parties at $1 30 per pound, including the tin canister and packing case.

OTHER COMPOUNDS OF SODA.

BISULPHITE OF SODA.

There is no improvement in the ordinary way of making this material, viz., by passing sulphurous acid, made in any way found cheapest and most convenient, into a solution of carbonate of soda. Its use is extending more and more every day, frequently under the name of leucogene, for bleaching wool; also for bleaching vegetable textile matters, as cotton, linen, hemp, jute, phormium, &c. It gives a silky white color to threads and tissues that cannot be obtained by hypochlorites. M. Chaudet, of Rouen, manufactures annually 140 tons of leucogene, representing 2,000 tons of white wool. In 1866 he first applied bisulphite of soda and indigo to the blueing of wools. The process is to add to the ordinary leucogene from three to five parts by weight of blue dye for every 100 parts of wool to be bleached. The bleaching and dying take place at the same time.

HYPOSULPHITE OF SODA.

The use of this substance, which commenced with the art of Daguerre, has since extended to a variety of uses. As an antichlor, it is introduced into paper pulp to decompose the last traces of bleaching powder, which, if allowed to remain, attacks the paper and renders it brittle and friable; in the manufacture of antimony vermillion by the action of this hyposulphite or the salts of antimony, especially the terchloride; in metallurgy, after treating silver ores so as to form the chloride of silver, this chloride is dissolved out by the hyposulphite of soda. So much of this salt is now used that one establishment alone in Lancashire makes three to four tons a week. This salt is made in two or three ways. Kopp's method is to form it by a double decomposition with carbonate of soda and hyposulphite of lime. This substance can be readily obtained by oxidizing the soda-waste and submitting it to the action of carbonate of soda and evaporating the resulting solution of hyposulphite of soda to the point of crystallization. It is also formed by first converting the sulphate of soda into the sulphide by heating with carbon, dissolving in water, and treating by a current of sulphurous acid until the reaction is acid, neutralizing with a little caustic soda and evaporating to crystallization. Sometimes stacks of coke are used to bring the sulphide of sodium and sulphurous acid in contact, the solution of sulphide trickling downwards and the sulphurous acid gas ascending.

CHAPTER III.

POTASH AND ITS COMPOUNDS.

Principal sources and uses of potash and its compounds—Potash from feldspar—Method of decomposing silicates—Extraction of potash-salts from sea-water by Balard's process—Merle's improvement—Potash-salts from the rock-salt mines of Prussia—Geology of the Stassfurt deposits—List of the mineral species found at Anhalt and at Stassfurt—Theory of the origin of the deposits—Extraction of the potash-salts—Sulphate of potash—Nitrate of Potash—Potash from organic sources—Extraction from wood ashes—Extraction from ashes of sea-weed—Extraction from suint in sheep's wool—Use of potash-salts in agriculture.

PRINCIPAL SOURCES AND USES OF POTASH AND ITS COMPOUNDS.

In years gone by, potash was the cheapest of the alkalies used in the arts, but that time has passed, and this alkali is now the most expensive of all, and consequently soda and ammonia have taken its place to a great extent. It is still, however, essential for some purposes where soda cannot be used, as for example, in the preparation of pure crystal-glass, to which soda gives a greenish hue, as potash-nitre in the formation of gunpowder, and in the formation of chlorates and cyanides. In the last series of compounds, the cyanides, baryta may in the future take the place of potash to a considerable extent.

Potash is furnished to commerce from the mineral, vegetable, and animal kingdoms; it is procured from products both from the land and from the water. The method of obtaining potash from the incineration of terrestrial plants is so well known, and was for so long a time the only way of obtaining this alkali, that any notice of it further than a mere mention is unnecessary.

POTASH FROM FELDSPAR.

There have been many attempts to separate potash from feldspar, (in which it exists in considerable quantities,) so as to produce it, economically, in large quantities for commerce, but no one has come so near accomplishing this successfully as Mr. F. O. Ward, in 1861. At the Exposition in London there were specimens of potash manufactured according to his process. He called the process of decomposing the feldspar the *calcfluoric attack*, and he describes it as follows: "The feldspar, or other alkaliferous silicate which it is proposed to treat, is ground to the fineness of ordinary Portland cement, and mixed with a due proportion of fluorspar or other fluoride, also in powder. With this mixture a certain quantity of chalk, or preferably of a mixture of chalk

and hydrated lime, is incorporated, the mixture thus prepared is ignited at a yellowish red heat till the ingredients become agglomerated; this effect is obtainable in a time which varies from one to several hours."

The reporter may be excused for remarking, that although Mr. Ward is entitled to full credit for successfully carrying out this process into manufacturing chemistry, the reporter pointed out this process of decomposing silicates to obtain the entire amount of their alkalies eight years before Mr. Ward practiced the method. The process was proposed and used by the writer for analytical purposes, and reference is made to a memoir on determining alkalies in minerals, published in the American Journal of Science, March, 1853. The reader of this report may contrast the following, taken from that memoir, with Mr. Ward's description as previously given: "Pulverize the silicate to a sufficient degree of fineness, it is not required that the levigation be carried to any great extent; mix intimately a weighed portion of the mineral with one part of fluorspar and four parts of carbonate of lime, introduce it into a platinum crucible. The crucible may then be covered and introduced in any form of furnace where a bright red heat can be procured." Reference is here made to this early use of the process, because in the report upon the exhibition of 1862 it was stated that all attempts to decompose the silicates successfully, with lime and fluxes, had failed of success.

This process for manufacturing potash has not been attended with the practical success expected in 1862, various causes having conspired against it, some of which will be alluded to hereafter. Considering this want of success, the details concerning it need not be given. It is a process which is not familiar to most of the technical chemists in this country; in fact, strictly speaking, it has not been carried out on a manufacturing scale, the largest charges operated upon being 240 pounds, and the yield seven-eighths of the potash present.

POTASH SALTS FROM SEA-WATER—BALARD'S PROCESS.

This is another mineral source of potash salts, and it was first devised by Balard some sixteen or eighteen years ago, and has been carried on successfully for many years, but is now seriously interfered with by the supply from the new source of potash in the deposits of potash compounds called "sylvine" and "carnallite," found occurring in the rock-salt mines of Stassfurt.

By Balard's method the potash salts are obtained in treating the mother-liquor of sea-water salt works, which we may regard as essentially composed of chloride of potassium, sodium and magnesium, and sulphate of magnesia. The object had in view is to bring all the sulphuric acid into combination with the soda, and then to obtain, by separate crystallisations, the chloride of sodium, the chloride of potassium, and the chloride of magnesium; the last, being of but little practical value, is allowed to run to waste. The means used to accomplish the results are alto-

gether physical, namely, the abstraction of heat by natural or artificial means. It is based on Scheele's observation made a great number of years ago, that if a mixture of chloride of sodium and sulphate of magnesia in solution be reduced below freezing point, a double decomposition takes place, and crystals of hydrated sulphate of soda are formed, and choride of magnesium remains in solution. The separation of the mixed chlorides is made by boiling and cooling the mother-water freed from the sulphate of soda. The original process of Balard was much improved by M. Merle, who employs an artificial cooling process. The following is a detailed description of his process, as communicated by him to the chemical reporters of the London Exposition in 1862:

The process may be shortly defined to consist in the further concentration of concentrated sea-water by exposure to a low temperature, artificially produced. The degree of concentration requisite to fit sea-water for treatment by this process is 1.24 sp. gr., (28° B.,) at which point of concentration sea-water deposits about four-fifths of the culinary salt contained in it.

This degree of concentration is obtained by the ordinary process of evaporation on the ground as practiced in the manufacture of common salt, of which the ample crop obtained repays this preliminary operation. The mother-liquor which remains is the raw material of the new process. It is stored in large covered tanks, and from this point forward it undergoes no further exposure to dilution by rain, or to absorption by the soil. It is withdrawn from the ordinary operations of the salt gardens, from which M. Merle borrows the one first step—concentration of 1.24 sp. gr., (28° B.) As, however, this degree of concentration is found to be a little beyond the density most favorable to the next stage of the operation, ten per cent. of pure water is added to the liquor in the tanks. Thus prepared, the concentrated sea-water is next passed through refrigerating vessels, which are constructed on Mr. Carré's principle, and which cool it to 18° C. This artificial refrigerator causes the desired double decomposition to take place between the sulphate of magnesia and chloride of sodium, sulphate of soda being deposited by the water as it passes through the machine, and chloride of magnesium being carried away in solution. The process is continuous. The water passes constantly in at one end of the apparatus and out at the other, and the deposited sulphate of soda is continuously withdrawn from the apparatus by a chain of buckets. This salt is speedily freed from mother-liquor by a centrifugal hydro-extractor, and is finally dried in a reverberatory furnace. The utility of the above-mentioned dilution of the tank liquors is now made manifest. If cooled down while at their original density (28° B.) they would let fall much hydrated chloride of sodium, along with the sulphate of soda, to the detriment of its purity and value. But in consequence of the dilution the culinary salt remains dissolved, together with potassic and magnesic chlorides, in the mother-liquor which flows away from the machine.

This mother-liquor has now to be treated for the recovery of the salts it holds dissolved. For the recovery of the culinary salts the mother-liquor is made to flow from the cooling machine directly into boilers like those used in refining rock salt. In these it is boiled down to 1.331 sp. gr., (36° B.,) by which time it has deposited nearly the whole of its common salt in a fine powder, which, when dried in a centrifugal machine, equals for purity the best English refined salt. It only remains now to recover the chloride of potassium still dissolved in the hot liquor, which, for this purpose, is poured forth to cool in extensive shallow coolers formed of concrete. Here it soon deposits the whole of its potash as a double chloride of potassium and magnesium. This deposit (a kind of artificial carnallite) is collected, and the magnesic chloride is eliminated therefrom by adding to the mixed mass half its weight of fresh water. This dissolves the whole of the more soluble magnesic chloride, but only one-fourth of the potassic chloride. Three-fourths of the potash are thus obtained as a chloride, containing only one-tenth of extraneous saline matter; the remaining fourth, dissolved with the magnesic chloride in the wash-water, is returned to the boilers.

This capital process works with the utmost ease and regularity. The energetic action of the artificially lowered temperature not only dispenses with the successive eliminations which form the basis of M. Balard's method, but causes the double decomposition to take place with such intensity that the mother-liquors retain but a small proportion of sulphate of magnesia, and lend themselves with ease to the further treatment for obtaining the potash salts. Thus, when the liquid is heated in the boilers nearly the whole of the chloride of sodium separates without carrying down with it any potash; and when the double chloride is deposited by the subsequent cooling, no potash is left in the waste liquor. The whole of the potash is thus precipitated as double chloride; and, this salt being very pure, nothing more is required, in order to obtain separately the chloride of potassium, than to wash out the chloride of magnesium with cold water and to dry the residue in the centrifugal machine. A very remarkable feature of M. Merle's process is the great facility with which the chloride of sodium is obtained in a finely divided state by ebullition in the boilers. If the liquor of 1.24 sp. gr. (28° B.) were boiled down without previous elimination of the sulphate of magnesia by the above-mentioned cooling process, crusts would form on the bottom of the boiler to such an extent as to hinder the operation greatly, if not entirely to stop it. But the double decomposition which takes place under the influence of cold, by depriving the liquor of sulphate of magnesia, and rendering it rich in chloride of magnesium, changes these conditions. Indeed, the liquor thus treated may not only be boiled down without the formation of the strongly adhering earthy deposits which would otherwise appear, but it does not even produce the slight crusts which form during the refining of rock salt; so that the preparation of the refined salt is carried on under very favora-

ble conditions. Ease and regularity are not, however, the only characteristics of this process. It is remarkable also for the large quantity of saline products which it is capable of yielding. In fact, the salt-work operation being limited to the production of a liquor of 1.24 sp. gr. (28° B.) on the ground, the loss arising from the permeability of the soil is quite insignificant, and not to be compared with the serious waste which results from this cause when the treatment of the liquor in the salt gardens is continued to much higher degrees of concentration, according to the earlier practice. In point of fact, the first stage of the treatment in the salt works, according to the original method, becomes the last stage in the improved plan. The saline water of 1.24 sp. gr. (28° B.) once transferred to the large tanks remains, during all further stages of the process, in metallic vessels; and, as the subsequent operations are conducted without loss, an amount of product is obtained which, when large evaporating surfaces are employed, may become enormous. A cubic metre of liquor at 28° B., which, if no loss occurred, would correspond to 25 cubic metres of sea-water, but which, in consequence of the loss occasioned by infiltration, is equivalent to 75 cubic metres of sea-water, yields, when treated as above described, 40 kilograms of anhydrous sulphate of soda, 120 kilograms of refined culinary salt, and 10 kilograms of chloride of potassium.

POTASH SALTS FROM THE ROCK-SALT MINES OF PRUSSIA.

We will now examine one of the most interesting and important mineral developments made for many years, and one that has produced and is producing remarkable effects upon certain of the chemical arts, deranging the commercial value of potash from other sources, and giving rise to other pursuits: it is the discovery of immense quantities of chloride of potassium in the salt mines of Stassfurt, Prussia. Like many other valuable discoveries it was made by chance, and the value of it was so little esteemed at the time that it was looked upon as a nuisance by those who had made it. It soon, however, attracted the attention of the chemist, H. Rose, of Berlin, who recognized its great value, and communicated the fact to the Prussian government; and since then these potash compounds have acquired great importance, and are being extracted in large quantities.

GEOLOGY OF THE STASSFURT DEPOSITS.

The geological formation in the district of Stassfurt has been ably described by Daubrée, and in order that the deposits of the locality may be better understood an extended abstract of his description is here given:

It is known that the salt deposits which underlie the variegated sandstone of this locality, and which have accumulated to a thickness of about 200 meters, present differences at different depths. It is easy to distinguish four distinct levels, which, commencing at the bottom, are:

, of anhydrite, consisting of beds of rock salt, separated by thin beds f anhydrite, 107 meters; 2, that of polyhalite, in which the beds of ock salt are separated by thin layers of this mineral, 31½ meters; , that of kieserite, in which the rock salt is associated with this ydrated sulphate of magnesia, 17 per centum, and with carnallite, a louble chloride of magnesium and potassium, 13 per cent.—thickness, 8 meters; 4, the carnallite, or potash salt, consisting of a double chloide of magnesium and potassium. At this level the carnallite predomnates, and forms 55 per cent., the rock salt 25 per cent., and kieserite 6 per cent. In this last level is found tachydrite, a double chloride of alcium and magnesium; sylvite, a chloride of potassium; and kainite, combination of hydrated chloride of potassium and sulphate of magesia.

The explorations have developed the existence of a mass of carnallite qual to 6,000,000 tons of chloride of potassium. Shafts sunk over half mile distant one from another, one at Stassfurt and the other at nhalt, show analogous deposits. After striking the salt beds the folwing are the deposits passed through:

At Anhalt.	*At Stassfurt.*
ellow kainite, (hydrated chloride of potassium and sulphate magnesia.)	Carnallite.
arnallite, (chloride potassium and magnesium.)	Boracite.
ylvite, (chloride potassium)	Tachydrite.
ylvite, with kieserite	Red carnallite.
ieserite, (hydrated sulphate magnesia)...	White carnallite.
olyhalite, (hydrated sulphate potash, lime, and magnesia.)	Kieserite.
ock salt with anhydrite..................	Polyhalite.
	Rock salt with anhydrite.

The quantity of carnallite taken out of these two pits from 1861 to 866 has gradually increased from 2,500 tons to 150,000 tons, and this uantity is worked in thirteen establishments erected for the preparation f chloride of potassium. Manufacturers are already engaged in preparing austic potash and carbonate of potash from this chloride, and by a proess similar to that employed in the manufacture of soda. The effect as been to greatly diminish the cost of potash, to disturb its production rom other sources, and to extend its use even to agricultural purposes. s yet no other workable deposits of carnallite have been discovered, lthough it is found in small quantities in many other mines of rock salt, nd there is every reason to suppose that it will be discovered in large uantities elsewhere.

It was at a depth of 280 meters that the salts of potash, soda, and agnesia were first struck.

THEORY OF THE ORIGIN OF THE STASSFURT DEPOSITS.

How can the origin of this peculiar formation be explained? Professor Balard, who has so thoroughly studied the phenomena attendant upon the evaporation of sea-water in the salines, ventures the following explanation, which is a very reasonable one:

In evaporating the water, the first deposit contains carbonate of lime and traces of oxide of iron, and next there is produced sulphate of lime with two equivalents of water, then a layer of common salt followed by a deposit of sulphate of magnesia, and after a while potash appears and is deposited in the form of a double sulphate of potash and magnesia with six equivalents of water, then a double chloride of potassium and magnesium, all of which is finally covered with a concentrated solution of chloride of magnesium, containing the bromides, which infiltrates itself slowly into the soil.

Suppose, now, that the resulting products of this evaporation are not disturbed, and in the spring (the winter rains not having entirely redissolved the salts) a fresh quantity of sea-water is let in upon this deposit, the water thus introduced. while not sufficient to dissolve all the common salt and sulphate of lime, is sufficient to dissolve the salts belonging properly to the mother-waters. This new solution, being more concentrated than that of the former year, deposits more promptly upon its evaporation a layer of sulphate of lime, which covers the undissolved salt, then a new layer of common salt, then new layers of products from the mother-waters in the order already indicated. We will suppose the same operation to be repeated for a series of years, and each year a new layer of common salt to be deposited with an intervening thin sheet of gypsum, the density and quantity of the mother-water to be constantly increasing so that the soil can no longer absorb it. Suppose now from any cause whatever the influx of sea-water ceases, but that the evaporation goes on in the mother-water, furnishing, in the order above stated, the magnesia and potash salts. If now argilaceous deposits take place over these saline beds and protect them from the action of rain water, we have, as a final result, a thick bed of common salt lying on a bed of gypsum, and interleaved with thin sheets of it, thus separating the products of each successive year, and enabling us to count the number of years taken to form the salt bed, as the rings in wood mark the years of the tree.

To attribute the origin of the Stassfurt deposit to sea-water requires us to suppose that this locality was formerly an estuary of the sea, but this is not very probable, and the supposition of Bischof is more rational, viz: that this part of Thuringia was a point where, in the course of ages, has been evaporated the concentrated waters of a soil covered with saline efflorescences, the waters brought in by a continual influx, which a change in the configuration of the surface of the country interrupted at some later period.

There is one fact to be remarked in connection with the salts as they

found in the presumed case of evaporation in the salines, and as they ur in the salt mine, viz: that the salts in the latter are much less drated than in the former; the gypsum in the salines, with two equivats of water, being replaced in the mine by anhydrite, (anhydrous phate of lime) and the sulphate of magnesia with seven equivalents water in the salines replaced by the sulphate with one equivalent of ter, which facts would lead to the inference that after these bodies of ts were deposited they were subjected to an internal heat which caused s diminished hydration; a supposition that is strengthened by the sence of a *magnesian boracite*, that has been called stassfurtite, the acic acid being introduced by the eruptive phenomena, which may re also introduced hydrochloric acid vapor, giving rise to certain commds, the formation of which is most easily explained in this way.

t must not be overlooked, however, that the evaporation of the waters ler the two conditions we are contrasting must have taken place newhat differently, and consequently the associations of the acids and es would not be exactly the same in all cases, as the salts we have umerated from the salt mines will show, viz: *kainite* and *sylvite*, the mical composition of which has been mentioned elsewhere.

TRACTION OF THE POTASH SALTS FROM THE STASSFURT PRODUCTS.

There are five products separated for commerce from the saline matels of the Stassfurt mine. 1st, chloride of potassium; 2d, sulphate of ash; 3d, carbonate of potash, obtained from the sulphate; 4th, sulate of soda; 5th, potash compounds to be used with manures. It must borne in mind that common salt constitutes the bulk of the mineral m which the substances are to be separated; *carnallite* (the chloride otassium and magnesium) is the substance relied upon for the chloride potassium, and the general principle of separating this from its assote is about the same in all processes adopted. The saline compound furnished from the mine contains about 16 per cent. of chloride of assium, the remainder being chloride of magnesium (in chemical ociation with the chloride of potassium) and common salt. By judius treatment with a limited quantity of water the bulk of common t is left undissolved in a hot solution, which solution when drawn off osits crystals of chloride of potassium, containing 80 to 90 per cent. chloride of potassium sufficiently pure for commerce or for use in nufacturing other compounds. The mother water from the chloride otassium is concentrated, and the remainder of the potash is deposited combination with magnesium as the original salt, *carnallite*, which is lected and treated over again. The last mother water is a solution of oride of magnesium, and has not yet been utilized to any great extent. These operations are conducted by different manufacturers in different ys. None are so simple or so likely to be generally adopted as that of ssrs. Vorster and Gruneberg. They commence by purifying the raw terial, detaching mechanically as much of the common salt and sulphate

of magnesia as can be done conveniently, grinding the mass to a powder, and then treating this powder not with pure water, but with the mother water arising from a previous operation. This carries off the great bulk of the useless salts in solution, leaving the less soluble saline compounds which are sought after undissolved, as the chloride of potassium and chloride of sodium, the former of which is readily separated from the latter by judicious treatment with water. The quantity of chloride of potassium now manufactured annually at Stassfurt and Anhalt is from 20,000 to 30,000 tons, of about 82 per cent. potash salt, and it finds a market in all parts of Europe. In France it sells at the rate of about $40 a ton. It is thought by some that the production of this salt will destroy its manufacture from the mother water of salines, and interfere very materially with the manufacture of potash salts from other sources, but M. Balard has a different opinion, and his opinion on this subject possesses great weight.

SULPHATE OF POTASH.

This product is now formed in large quantities from the chloride obtained from the mines of Stassfurt, from the salines and elsewhere, by the action of sulphuric acid of 40°. But at the mines of Stassfurt, as the materials for manufacturing sulphuric acid are not to be found, this process is an expensive one; and this induced the government, owning the mines, to offer the products at a diminished price to manufacturers who would discover and employ a process of using the natural sulphates to furnish sulphuric acid to the potash. Without detailing the numerous experiments that were made, we will describe the process which has been adopted with success. It is based on the formation of the double sulphate of potash and magnesia, with the aid of the sulphate of magnesia occurring abundantly in the mines. This salt is formed by the addition of a suitable quantity of sulphate of magnesia to the chloride of potassium. But to do this it is necessary to obtain a sulphate of magnesia as free from the chloride of sodium as possible. Messrs. Vorster and Gruneberg have accomplished this successfully.

A metallic strainer with meshes of one millimetre is suspended at the surface of a mass of water, the strainer is filled with a mixture of common salt and monohydrated sulphate of magnesia, as it is taken from the mine. In a short time the salt dissolves, and the crystals of the monohydrated sulphate pass through the meshes and fall to the bottom of the vessel, for it is hardly soluble in a saturated solution of common salt. This powder of monohydrated sulphate completes its hydration and forms a solid mass at the bottom, which is taken out and can be used for forming commercial sulphate of magnesia and producing the double sulphate we are now considering. The double sulphate may have a portion of the sulphate of magnesia withdrawn from the sulphate of potash, which, with the remaining magnesia, can be at once treated by Leblanc's process for carbonate of soda and caustic soda. This method is followed in France, but in Germany the double sulphate is purified

still further by a boiling solution of chloride of potassium, which on cooling gives at first a large crop of pure sulphate of potash, afterwards sulphate of potash and magnesia, and lastly, chloride of potassium and magnesium. The two last salts are treated over again, the first can be applied to any uses desired for sulphate of potash. This last decomposition does not necessarily require the agency of heat; the use of the chloride of potassium properly directed will accomplish the same results, but it requires more careful manipulation, and a very large amount of the solution of chloride. The sulphate of potash obtained from the salt mines of Stassfurt, as well as that obtained from the salines in France and elsewhere, is principally used in the production of carbonate of potash by Leblanc's process, so extensively used and well known for the formation of carbonate of soda.

NITRATE OF POTASH.

This compound is another potash product of the mineral kingdom; it occurs in the surface soil of many tropical regions where the composition of the soil and the atmospheric conditions are favorable to its formation. The East Indies furnish the principal quantity used in the arts. A deposit of some importance has been discovered in the Clan William district at the Cape of Good Hope. The nitrate of potash is extracted by the well-known process of lixiviation, is crystalized and purified, and is used principally in making gunpowder.

POTASH FROM ORGANIC SOURCES.

EXTRACTION FROM WOOD ASHES.

It is reasonable to suppose that the production of potash from this source has reached its maximum, not simply from the increased value of the wood from which it is produced by incineration, but principally from the increased and increasing production from the mineral kingdom. At present the vegetable sources of potash are the ligneous plants of Russia and North America, the herbaceous plants of Hungary, and the beet-root products of France. The annual supply from several countries has been of late about as follows: Russia, 9,500 tons; the United States and British America, 13.000 tons; France, 2,500 tons of carbonate of potash, purer than any other in commerce. France, in producing this quantity of carbonate of potash from the beet root, furnishes from these same beet roots, 200,000 tons of sugar and 100,000 tons of molasses.

The entire annual yield of potash known to commerce is about 30,000 tons, and this, when placed alongside of 500,000 tons, which is not far from the present product of soda, shows comparatively what an insignificant part potash occupies in the arts when contrasted with soda.

The production of potash from the beet root is one of great interest in certain countries, where this plant is grown for making sugar, and there are many details that would interest the manufacturers in those

countries, but which are not yet of much interest in this country. It will suffice to state that the molasses from the beet root is not an article of consumption, therefore most of it is fermented and distilled for alcohol, and the residual liquors in the still, when evaporated to dryness and burnt, furnish potash salts, which are subsequently purified.

POTASH SALTS FROM THE ASHES OF SEA-WEED.

It is no object here to enter into the peculiarities connected with the varieties of sea-weed incinerated for its salts, the general subdivision is into "drift-weed," and "cut-weed;" the latter of which is regularly reaped, while the former, being from deep soundings, is floated to the shore by the tide. The drift-weed is richer than the cut-weed, both in iodine and potash salts, especially the chloride. Twenty-two tons of wet sea-weed are required to produce one ton of kelp, yielding (besides iodine, bromine, and mixed soda salts) about 500 to 600 weight of commercial chloride of potassium, containing 80 per cent. of pure chloride, the other 20 per cent. being chloride of sodium and sulphate of potash. There is no new development in regard to the treatment of the kelp for the separation of its constituents, and as the working of chloride of potassium at Stassfurt is now carried on so extensively, it is doubtful whether kelp will in future have much value as a source of potash. It will be valued chiefly for the iodine it contains. In 1862, the chloride of potassium, corresponding to 46 per cent. of oxide of potassium, averaged a little over $100 per ton, making real potash cost nine and a half cents a pound, while that from American ash costs thirteen and a half cents per pound.

EXTRACTION OF POTASH FROM THE "SUINT" OR POTASSIC SUDORATE IN SHEEP'S WOOL.

This source of potash is not known in this country, and hardly anywhere else than in a certain part of France. Potash from this source formed an article of exhibition in 1867, as well as in 1862, and as the source is a curious one, and the process of obtaining it is not generally known, there is sufficient reason for describing it to the American technologist somewhat in detail. The nature of this source of potash was reported on in 1862, for the London Exposition, by Hofmann, and free use has been made of his description.

It is well known that sheep draw from the land on which they graze a considerable quantity of potash, which, after circulating in their blood, is excreted from the skin with the sweat, in combination with which it is deposited in the wool. Chevreul pointed out that this peculiar compound, by the French called "suint," forms no less than a third of the weight of raw merino wool, from which it may be readily dissolved out by simple immersion in cold water. In coarser wools it is less abundant, and, according to MM. Maumené, and Rogelet, the potassic sudorate or suint of ordinary wools forms, on the average, about 15 per cent. of the weight of the raw fleece.

This compound was formerly regarded as a soap; doubtless because wool contains beside the suint a considerable proportion (about 8½ per cent.) of greasy matter, (Chevreul.) This grease, however, is, in fact, combined with earthy matter, chiefly lime, as an insoluble soap. The soluble sudorate is, according to MM. Maumené and Rogelet, a neutral salt, resulting from the combination of potash with a peculiar animal acid, of which little is known beyond the fact that it contains nitrogen.

At the great seats of the woolen manufacture in France, as at Rheims, Elbœuf, and Fourmies, the new industry of MM. Maumené and Rogelet, is either established or in course of establishment. Their plan is to buy of the woolen manufacturers the solutions of suint obtained by the immersion of their raw fleeces in cold water; paying higher, of course, for those liquors in proportion as they are stronger; thus, for example, for the suint from a ton of wool they pay five francs, if diffused through 27 hectolitres of water, (sp. gr. 1.030;) whereas, for the same quantity of suint they can afford to give no less than 18 francs, if it be concentrated in 3 hectolitres of water, (sp. gr. 1.250;) and so in like proportion for the suint liquors of intermediate strength.

An ordinary fleece, weighing four kilograms, contains, according to MM. Maumené and Rogelet, about 600 grams of sudorate of potassium or suint. This, according to their analysis, should contain 33 per cent. of its weight, *i. e.*, 198 grams of pure potash. Of this, according to another estimate, (showing the nitre it would produce,) they appear to reckon on about 173 grams as being practically recoverable.

The wool manufacturers of Rheims wash annually 10,000,000 kilos of fleeces, those of Elbœuf 15,000,000 kilos, and those of Fourmies 2,000,000 kilos—total 27,000,000 kilograms, the produce of 6,750,000 sheep. From this quantity, were it all subject to MM. Maumené and Rogelet's treatment, 1,167,750 kilos of pure potash would, according to the above ratio, be recoverable. The value of the potash, as carbonate, reckoned at the average price of American potash, would range between $400,000 and $450,000. The wash-water yielding it, if paid for at MM. Maumené's and Rogelet's minimum price, would cost about $100,000. Hence it appears that the process of MM. Maumené and Rogelet may be worked on a large scale and with very ample profit. MM. Maumené and Rogelet compute that there are 47,000,000 sheep in France—nearly seven times as many as those above calculated on. And they point out that if the fleeces of these were all subjected to the new treatment France would derive from her own soil all the potash she requires; enough, they observe, to make 12,000,000 kilograms of commercial carbonate of potash, convertible into 17,500,000 kilograms (about 17,500 tons) of saltpetre; with which, as they characteristically add, 1,870,000,000 cartridges could be charged. The difficulty of collecting the wash-waters of fleeces, scoured in small numbers by the farmers all over the country, is a great bar to such an extension of the process.

The value of potash as a manure is naturally indicated by the com-

EMPLOYMENT OF POTASH SALTS IN AGRICTLTURE.

position of all land plants, for they rob the soil of more or less of this constituent. As a general thing, in our rich and virgin soil there is potash enough to supply vegetation for a long time, particularly as the slow decomposition of the particles constituting the soil liberate more or less of this alkali. In Europe, however, the case is different, and every artificial means is resorted to to restore and replenish the potash of the soil. The new and abundant mineral source of potash salts has awakened the attention of agriculturists in Europe, and now the only question for solution is the best way of applying them. On this subject opinion is still divided, but it has been satisfactorily ascertained by experiments in both France and Germany that practical benefit can be derived from them. Owing to the fact that potash in the United States is too costly for agricultural purposes, and that there is no likelihood of its being resorted to at present, no details will be given of the European experiments. The chloride of potassium is the salt generally used.

CHAPTER IV.

AMMONIA, BARYTA, MAGNESIA, AND ALUMINA.

AMMONIA AND SALTS OF AMMONIA—APPARATUS FOR MAKING AQUA AMMONIA—DETAILS OF THE OPERATION OF DISTILLING—BARYTA AND ITS COMPOUNDS—PERMANENT WHITE—MAGNESIA AND THE MAGNESIA-SALTS—OXYCHLORIDE OF MAGNESIUM; ITS PROPERTY OF SOLIDIFYING—ALUMINA AND ITS COMPOUNDS—ALUMINATE OF SODA; ITS USES IN DYEING—ALUMINA—SULPHATE OF ALUMINA—ACETATE OF ALUMINA—ALUM.

AMMONIA AND AMMONIA SALTS.

But little advance has been made in the manufacture of the ammonia compounds. Ammonia is now derived almost exclusively from gas works, it being one of the products of the distillation of coal in the manufacture of gas. It is true that coal contains but very little nitrogen, not averaging over one per cent., but when it is recollected what an immense quantity of coal is used in making gas, even this small quantity of nitrogen yields in the aggregate a large amount of ammonia. In London over 1,000,000 of tons of coal are used annually in making gas, and supposing one-third of the nitrogen to enter into the formation of ammonia, this amount of coal will represent about 10,000 tons of sal ammoniac. But even this source of ammonia does not meet the demands of the arts, especially as it is largely taking the place of potash in alum and other compounds. A still larger amount of coal is used for other purposes than making gas, and in many instances is so burnt that with but little ingenuity it may be made to increase the yield of ammonia when it becomes an object. The coking furnaces would be a prolific source, and already in the Paris gas works much coke of a very beautiful quality is made in coking ovens, and the gas as well as all other volatile products are saved.

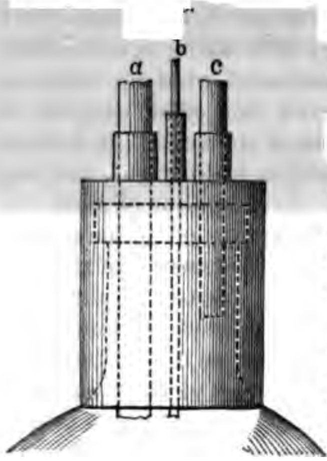
The manner of procuring ammonia from the weak ammoniacal liquors is carried on with more system and economy in the Paris gas works than in any other works I visited. In the first place the liquors are not carried over two or three hundred yards, when they are emptied into a system of vats from which they are pumped into pans and neutralized by sulphuric or hydrochloric acid and crystallized and purified; or they are conducted to a set of stills, most ingeniously devised, but which could not be fully explained without a number of drawings. It is a system of stills and condensers, so arranged that their operations are nearly automatic, where the water is treated with caustic lime, and the ultimate result is an ammonia of every variety of commercial strength and of a sufficient degree of purity to be put upon the market at once. It is in part like the apparatus figured below for making ammonia in the moist way from the ammonia salts of commerce.

APPARATUS FOR MAKING AMMONIA.

The following is a description of a form of apparatus which I devised several years ago, and with which I have made large quantities of ammonia at a very economical rate and without the slightest inconvenience to the operator. It can be made of any required size. Its construction and arrangement are clearly shown by the accompanying figure, (Fig. 4) on page 47.

REFERENCES TO THE FIGURE.

heet-iron with a man-hole at the end; B, feed-pipe for sol phate of ammonia; C, feed-tub, (half of a barrel;) D D′, wa E″, gas pipe; F F′, safety tube of one-eighth inch glass , placed in a 42-gallon barrel; to run off condensed aqueous I I′, bottle No. 1; K K′, bottle two-gallon stoppered bottle to rec eous ammonia.



Tin cap for neck of carboy.

Fig. ws the manner in which the tin ss tubes are fitted on the neck y bottles I and I′. *a* is a $\frac{3}{4}$-inch tube w reaches to near the bottom of the carboy; *b* is a safety glass tube of one-eighth of an inch; *c* is the exit tube which connects I with K.

The joints of the lead pipe are wrapped with bladder, while those of the glass or tin pipe are made with pieces of India-rubber tubing.

The tin caps on I and I′ are wrapped with bladder. Those on K and K′ are loose.

DETAILS OF THE OPERATION OF DISTILLING.

I. Introduce into each of the carboy bottles I I′ and K and K′ five gallons distilled water, unless some weak ammonia is left from previous distillation, when substitute six gallons of this in I and I′.

II. Introduce into D and D′ water up to the mark X and X′.

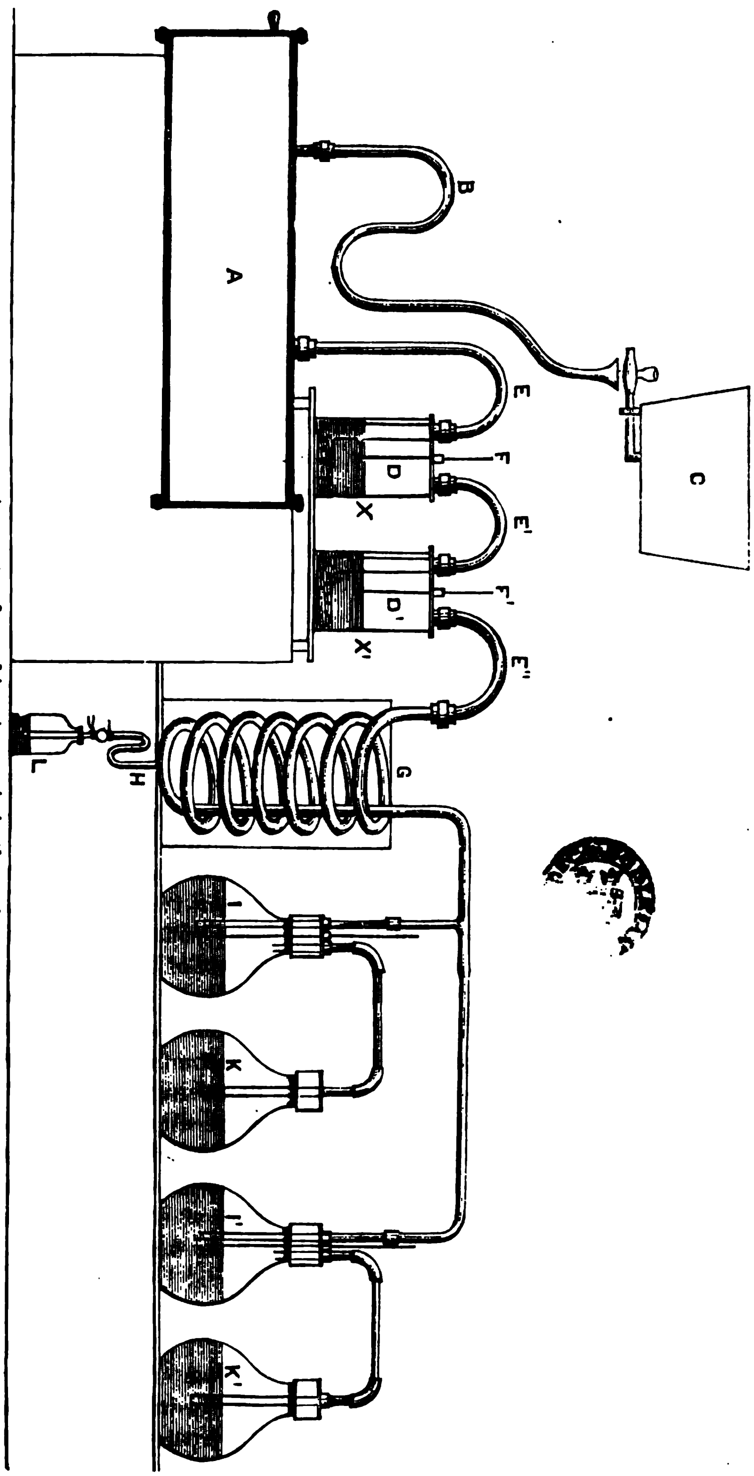
III. Introduce into L sufficient water to cover the orifice of the trap H.

IV. Introduce into A 100 pounds fresh lime, lute the manhead in and bolt securely.

V. Having secured all the joints, allow a solution of 120 pounds sulphate of ammonia in 40 gallons water to flow from the tub C, through pipe B into A, and allow the apparatus to stand until next morning.

VI. Early in the morning proceed to distillation. By the aid of a gentle fire, the intensity of the distillation is regulated by safety tubes F F′, from which none of the wash water should be ejected. If the latter occurs the fire must be dampened.

Fig. 4.



Apparatus for making Ammonia in the moist way.

VII. The cooled gas will bubble into carboys I and I', for several hours after which it works very slowly and ceases in the course of five to six hours, when they are disconnected and the block-tin pipes stopped.

VIII. From the very beginning, aqueous ammonia will accumulate in the receiver L, and this continues long after the gas has ceased to pass into the carboy. The first four gallons are generally concentrated (26°) ammonia. The next six to ten gallons will sometimes be 20° ammonia, but generally only 16°; what passes after this is weak ammonia and may be used to fill I and I' in a new operation. The distillate is collected at L as long as it smells strongly of ammonia, after which the process is discontinued.

IX. When weak ammonia has been used to fill I and I' the carboys generally contain 20° ammonia; otherwise it is between 16° and 20°, and may either be brought to 20° with the first four gallons distilled of L, or reduced with weak liquids into carboys K and K'. These latter are, however, generally not disturbed until after three or four operations, when they will generally make 16° ammonia.

X. After cooling, the contents of the retort are drawn out at the man-hole and the retort can be recharged in the manner described.

BARYTA AND ITS COMPOUNDS.

A few years ago this substance and its compounds possessed no special interest for industrial chemists; but later, their labors, especially of Kuhlmann, have brought these compounds conspicuously before the public.

Caustic baryta is not far from rivaling potash, soda, and ammonia in its caustic property, and it is not a bad substitute for potash in the chromic acid compounds. The artificial sulphate of baryta has received a special application by Kuhlmann, and he turns out two tons a day under the name of *permanent white;* but it mixes badly with oil, and has to be incorporated with white lead. The natural sulphate of baryta is very commonly used, as well known, to adulterate white lead. In the Exposition of 1867 Kuhlmann did not show that he had made any progress in his treatment, formation, or application of the baryta compounds, nor had any other exhibitor shown any of its compounds deserving special attention. The only novel application of any interest that the sulphate of baryta has received under the name of permanent white, is in the manufacture of a paper of a pure white in imitation of linen, which is used in making collars and objects of both male and female attire where the washing of such articles of linen amounts to more than their first cost when made of paper.

MAGNESIA, AND MAGNESIAN SALTS.

The only thing new in relation to magnesia compounds is the efforts to utilize more and more the chloride of magnesium, formed in the salines, especially at Stassfürt. The chloride is treated in solution with

a little less than one equivalent of lime; a double decomposition ensues, forming magnesia and chloride of calcium; this last is heated to fusion with the natural sulphate of baryta, and chloride of barium is produced, and is used to form the precipitated sulphate, the "permanent white," for the uses already mentioned.

OXYCHLORIDE OF MAGNESIUM.

Here we have an entirely novel application of the chloride of magnesium and magnesia, which, should it meet with the success that it promises, will furnish a source of consumption of much of the chloride of magnesium and magnesia which is now almost useless. M. Sorel, to whom I believe we are indebted for the invention of the process of forming a solid compound in a few minutes, by the mixture of the chloride of zinc and oxide of zinc, noticing that chemists ranked magnesium alongside of zinc, was led to examine the property of an oxychloride of magnesium formed in a way similar to the zinc compound, when he ascertained that the result was similar, viz., the rapid formation of a solid compound, but at a much less cost.

This mixture, besides possessing the property of solidifying, can become the agent of agglomerating considerable quantities of foreign substances.

The magnesia used is that obtained by calcining the carbonate brought from Greece, or that procured by precipitation from the chloride of magnesium, coming from the salines and other sources. M. Sorel mixes the magnesia with a solution of chloride, of 30° Baumé, forming a soft paste that can be molded like plaster of Paris. It is white, and resembles ivory, being slightly translucent, and it can be colored by any of the mineral colors. In twenty-four hours it becomes solid, its solidity increasing with time, finally attaining the cohesion of marble, which it resembles. It is already used in forming mosaic on marble, by first placing the desired designs on white marble with printer's ink, then corroding the surface with hydrochloric acid, afterwards filling up the depressions with the oxychloride of magnesium freshly made. Consolidation is allowed to take place, and then the surface is polished off. It is also used by Messrs. Martin & Sauvo for making a mixed mosaic of wood and cement, that has a very pleasing effect.

A conglomerate is made of one part of magnesia, 30 to 40 of sand or calcareous matter, and moistened with a solution of 25° density of chloride of magnesium. This conglomerate, it is said, can be made for $6 a cubic yard. If all that is claimed for this cementing substance is correct, its use will be very rapidly extended for building purposes. But from all the light I could obtain from a critical examination of the substance, it is to be feared that it will not resist the atmospheric influences of moisture, &c. It is also recommended by the discoverer to use a very soft mixture of this substance to protect porous stone from the action of the weather, applying it by means of a brush.

ALUMINA AND ITS COMPOUNDS.

This class of compounds has very extensive applications in the arts. It is used in paper making to a considerable extent, not, however, to improve the quality of the paper, but rather to increase the profits of the manufacturer. It is necessary in the formation of organic lakes, and is a valuable as well as an extensively used mordant in dyeing and printing on textile fabrics.

ALUMINATE OF SODA.

This is a new product of comparatively recent introduction into the arts. Its origin is due in a great measure to the use of a mineral called *beauxite*, found in France, in the departments of Bouches-du-Rhone, and of the Var. There are one or two less acceptable localities of this mineral. This beauxite is a ferruginous mineral, containing a large amount of alumina. It contains:

Alumina	60 to 75 per cent.
Peroxide of iron	12 to 20 per cent.
Silica	1 to 3 per cent.

The aluminate of soda may be obtained by treating the powdered mineral with a concentrated solution of caustic soda, and boiling. Or it may be heated with carbonate of soda in a reverberatory furnace, and the mass when cool treated by lixiviation, and filtered by a vacuum filter, steam being used to heat the water for lixiviation, and by its condensation to form a vacuum beneath the filter. By evaporating the solution to dryness, the anhydrous aluminate is obtained in the form of a dry white powder, of a greenish tinge. As brought into commerce, it contains:

Soda	43
Alumina	48
Sulphate and chloride of sodium	9

These last come from the impurities in the soda ash, but do not interfere with the uses to which it is applied. The silica that beauxite contains remains insoluble in the form of alumina-silicate of soda. The aluminate of soda is a very infusible substance, resisting a very high temperature. It is very soluble in water, cold water dissolving as much as hot water. A concentrated solution will, however, slowly deposit alumina, leaving an aluminate with an excess of alkali in solution.

USES OF ALUMINATE OF SODA.

This substance is used to form alumina; it is also used as a mordant in dyeing, and on certain descriptions of woolen goods is said to heighten the color to a greater extent than any of the alums.

ALUMINA.

It is useless to refer to the old methods of obtaining this substance; reference will only be made to the more recent method of preparing it

from *aluminate of soda*. This is done by passing a current of carbonic acid, made in any way whatsoever, through the solution. The process used at Natrona is described under the head of soda from cryolite. The carbonic acid is passed through a long horizontal cylinder furnished with agitators. The carbonic acid completely decomposes the aluminate, and the alumina is deposited in a dense powder, if the solution is concentrated. The alumina thus obtained is now ready to be used for the formation of alum, and other uses to which this earth is applied. It, however, contains a little carbonate of soda, and can only be obtained free from it when precipitated by hydrochloric acid.

SULPHATE OF ALUMINA.

Sulphate of alumina is prepared from the alumina precipitated from aluminate of soda, and can be produced without excess of acid or the presence of any iron. The use of this substance is gradually extending in the art of dyeing and making paper. To convert alumina into the sulphate, it is put into a vessel lined with lead, with a rounded bottom, and so elevated that it can be readily emptied. Sulphuric acid is added, diluted with a quantity of water, so proportioned that with the water in the alumina there will be just the amount which is expected to remain in the sulphate. The fluid mass is rapidly agitated, in which there is no reaction at first, but in a few minutes it commences, and goes on with great vigor, so much so as to require vigorous agitation to prevent its foaming over the side of the vessel. When the reaction is over, the mass settles down and must be at once poured out by inverting the vessel. All the sulphate which is still fluid runs on to a large plate of lead with the edges turned up, when it soon becomes solid. The operation is repeated in the same vessel, and the contents are poured on to the former and cooled mass, and so on until the mass of layers is sufficiently thick, when the cake is broken up and packed to be sent to market. It contains one equivalent of sulphate of alumina and eighteen equivalents of water. It is purer and can be sold at a less price than alum, and contains a greater equivalent of alumina to the same weight, so that it must ultimately drive out, to a great extent, the use of alum in the arts.

Sulphate of alumina has very recently been formed in the province of Liege by passing the vapors formed in roasting zinc blende through immense accumulations of decomposed alum schist, formerly used for procuring alum, these accumulations being the residues of ancient works. As these conditions are, however, local in their character, no details will be given of them.

The method employed at Natrona, Pennsylvania, for forming the sulphate of alumina is the following:

For converting the alumina into a sulphate, it is added, in small portions at a time, to a boiling solution of dilute sulphuric acid of about 30° Baumé, until rather more alumina has been used than is sufficient to

form the tersulphate of alumina, the chemical formula of which is $Al_2O_3+3SO_3$, having an excess of alumina always present. After boiling a few hours the liquor is tested, and as it is prepared in the arts to have the proportions of a slightly basic sulphate, these are adjusted so that for each equivalent of alumina present there should be $2\frac{8}{10}$ eq. of sulphuric acid, or $\frac{2}{10}$ of an eq. less than the sulphate, as it exists in common alum. The solution is then allowed to remain at rest for some days, until perfectly clear, when it is decanted into copper vessels, and evaporated until a drop of it solidifies into a hard, brittle mass. It is then collected into leaden molds to cool, when it is packed in boxes or barrels for market. Sulphate of alumina as thus prepared is of a white, translucent color, having the hardness and appearance of alabaster. It contains mere traces of iron, and, as before said, there is present in combination also sulphuric acid, as with alumina in common alum. It also contains about 15 per cent. of alumina, or about one-half more than is present in an equal weight of common potash alum. It is on account of its basic properties, and consequent freedom from acid, its small amount of iron, its trifling cost, that, by calico-printers, sugar-refiners, paper-makers, &c., it is consumed in immense quantities.

Sulphate of alumina of this character can be prepared only from alumina obtained from cryolite, as that prepared from alum, clays, or other sources of alumina, cannot be free from a great excess of acid, which undoubtedly destroys its usefulness for many purposes and injures it for the arts.

ACETATE OF ALUMINA.

Instead of making this salt as formerly by a double decomposition between acetate of lead and alum, it is now formed by dissolving precipitated alumina in acetic acid, care being taken, however, to use alumina precipitated by hydrochloric acid, as that precipitated by carbonic acid retains a small amount of carbonate of soda, which impairs very materially its solubility in acetic acid.

ALUM.

The different forms of alum for some time in use are still employed as potash alum and ammonia alum; the latter has, however, superseded to a great extent the former, as it can be manufactured more cheaply. In England more than one-half the alum manufactured is ammonia alum, about 8,000 tons of it being manufactured annually in the different works in that country.

CHAPTER V.

CHLORINE, FLUORINE, MANGANESE AND CARBONIC ACID.

HYDROCHLORIC ACID PRODUCED IN THE MANUFACTURE OF SODA-ASH—GOSSAGE'S PROCESS OF CONDENSATION—MERLE'S PROCESS—PRODUCTION OF HYDROCHLORIC ACID AND SILICATE OF SODA—ARSENIC IN HYDROCHLORIC ACID—RECEPTACLES FOR THE ACIDS—CHLORINE, ITS PRODUCTION FROM HYDROCHLORIC ACID BY MANGANESE—RECENT IMPROVEMENTS IN THE MANUFACTURE—DUNLAP'S PROCESS—SCHLOESING'S—LAUREN'S—PROCESS BY CHROMATE OF LIME—CHLORIDE OF LIME; METHODS OF PREPARATION—CONDENSING CHAMBERS—UTILIZATION OF THE RESIDUES FROM THE MANUFACTURE OF CHLORIDE OF LIME—FLUORIC AND FLUOSILICIC ACID—GLASS FROM CRYOLITE—MANGANESE COMPOUNDS—MANGANATE OF POTASH USED IN BLEACHING—CARBONIC ACID, AND METHODS OF PREPARING IT FROM COAL.

HYDROCHLORIC ACID.

In the manufacture of soda-ash immense quantities of hydrochloric acid are produced, and formerly it was allowed to escape into the air or was condensed by water and passed into streams. The immense injury done to the lands in the neighborhood of the works, as well as to the water courses, have caused stringent sanitary regulations to be imposed on the soda factories. In England, from being very lax, they have become exceedingly stringent, and the present law requires that the hydrochloric acid should be condensed to the extent of ninety-five per cent. of the common salt used, and a rigid inspection makes the law efficient. In France, as much, until 1866, as one-half the acid escaped into the air, when the improvement of the construction of the furnaces rendered the condensation of the acid more perfect; and the interest of the manufacturers now acts more strongly than rigid laws to enforce the condensation of the vapors of the hydrochloric acid.

GOSSAGE'S PROCESS OF CONDENSATION.

There are several methods of bringing about the condensation of the acid gas, but that by means of stacks filled with coke or quartz pebbles is almost exclusively employed, and was originally used by M. Gossage. It is now extensively used in France, where three square stacks are used 18 metres in height and 1.20 meters square, constructed of sandstone or of bricks soaked with tar and filled with coke to one-eighth their height. After the gas has traversed five vats of compact sandstone, where the first condensation is effected, the gas passes in at the bottom of the stacks and ascends, encountering water that falls in a shower from above downwards; each stack has a small chimney, through which only a minute quantity of the uncondensed hydrochloric acid passes out.

Kuhlmann, and some others, condense the gas in a great number of

earthenware bottles. Kuhlmann uses as many as 250 vessels, each having a capacity of about twenty gallons; they are so arranged by a system of connections that the gas passes in one direction and the water in the opposite, and the condensation takes place at the surface, without the plunging of any tube beneath the surface of the liquid. The gas is finally passed into a vault underneath the works and is completely condensed by fragments of chalk.

MERLE'S PROCESS.

In the establishment of M. Merle, of Salindres, a mixed system is employed, condensing perfectly 95 per cent. of the acid produced. This system as described by M. Balard, who recommends it very highly, is as follows: This system of condensation is composed of two large earthenware vessels placed near to each other, in which the acid passes successively from one to the other; after these two vessels, there are two parallel rows of stoneware carboys of fifty gallons each, and these in their turn are followed by a single row of thirty carboys, at which distance the condensed gas occupies less volume. These carboys, are connected by elbows to which are joined two tubes of stoneware one meter long, giving to the combination the appearance of organ pipes, like the system of condensers in gas-works, all of which tend to cool the gas and render the condensation more speedy. The excess of gas passes to a conductor of stoneware tubes of 80 centimeters in diameter, the elements of which are maintained in a vertical position by a wooden structure; these tubes are filled with hollow stoneware balls, having a number of holes; this part of the condensing apparatus is nine meters in height and suffices for the nearly complete condensation of the gas, when water is introduced in proper quantity. This mixed system furnishes liquid acid of the density of 21°, avoiding the necessity of the manipulation of pumping the acid up into stacks, to be acted on several times by the acid gas before the requisite condensation is secured, viz, 21°, which is that required for the manufacture of chloride of lime.

There are other methods used for condensing the acid when there is no object to save it; by passing it into galleries containing limestone before it reaches the chimney which produces the draft. Tessier passes it through a lime kiln before it comes to the chimney, as the hot lime absorbs it more rapidly. In some places near the sea-shore the sea water is allowed to enter into galleries and the acid is condensed by the water.

PRODUCTION OF HYDROCHLORIC ACID AND SILICATE OF SODA.

It has been known for some time that the vapor of water will decompose common salt when they are heated together at the temperature of volatilization of the salt in connection with silica. In practice this operation is carried on by M. Gossage, not, however, for obtaining hydrochloric acid, but for obtaining silicate of soda used by him in the production of

a certain kind of soap. His apparatus is composed of a kind of cupola filled with coal, and from which escape currents of flame; it is a kind of generator of combustible gases. The flame plays over the surface of a reverberatory furnace containing common salt; this salt evaporates and passes off with the vapor of water that is injected into this furnace. The mixed heated vapors pass to a descending column filled with fragments of quartz; decomposition takes place, hydrochloric acid is liberated, the soda combines with the silica, and the silica of soda descends to the bottom of the column. This silicate of soda is used by M. Gossage for the formation of soap. It can also be decomposed by carbonic acid and furnish carbonate of soda. Hydrochloric acid is produced in large quantities; but as yet it is not collected or turned to any practical use.

ARSENIC IN HYDROCHLORIC ACID.

In hydrochloric acid prepared by arsenical sulphuric acid arsenic is sure to be found, and in some instances as much as half of one per cent. has been found. It can only be got rid of by the agency of hydrosulphuric acid.

RECEPTACLES FOR HYDROCHLORIC ACID.

The acid once formed, it becomes necessary to keep it in recipients before using it. Glass and earthenware carboys are commonly used, but latterly gutta-percha jars have been extensively substituted.

USES OF HYDROCHLORIC ACID.

The uses of this acid are principally confined to the production of chlorine; the other uses are insignificant compared with this. These uses are for dissolving the phosphate of lime from bones; in the manufacture of bicarbonate of soda; in certain operations in the bleaching of cotton; to form chloride of tin, chlorate of potash, sal ammoniac, &c., and it has been used in the production of phosphorus.

CHLORINE.

The common method of producing chlorine is still in use, viz: the reaction of hydrochloric acid on binoxide of manganese. In this, however, one-half of the acid remains combined with the manganese. This is of no material consequence when the acid is abundant and cheap. In some factories sulphuric acid is used to react on common salt and binoxide of manganese. This last substance, of course, forms a conspicuous part in this manufacture, and a good article is greedily sought after. Fortunately it is furnished in all parts of the world; among the best supplies to be found in the market are those coming from certain mines in Germany, Spain, and Nova Scotia. A very good article has also been obtained in California. There have been various processes proposed to form chlorine without the binoxide of manganese, but none of them

have been brought into practice or deserve any special notice, except Dunlap's, already referred to, under the head of sulphuric acid, and which is described more in detail a little farther on; also Schloesing's process, where he uses binoxide of manganese with a mixture of hydrochloric acid and nitric acid. Both of these processes were known more than five years ago, but are not familiar to most of those who may read this report.

RECENT IMPROVEMENTS IN THE MANUFACTURE OF CHLORINE.

In the manufacture of chlorine, the more recent improvements are confined to the vessels in which the decomposition is carried on. Two kinds of vessels are employed in France. In some establishments the vessels are made of sandstone cut out of a single piece, and holding about 250 gallons. These are encased in masonry, and are heated by steam that circulates between the masonry and the vessel, and which completes the decomposition by a jet thrown into the interior. There are some objections to this plan of heating. The jet of steam dilutes the contents of the vessel too much, so that latterly they have returned to the use of vessels of stone-ware, of fifty to sixty gallons capacity, furnished with a lateral opening, by which the chloride of manganese can be drawn off with a siphon and fresh acid introduced. These vessels have a large opening, in which a cylinder of forty centimeters diameter (perforated with holes) can be introduced. These cylinders are filled with manganese in small lumps, and they are introduced only partially into the acid, so that all the manganese is not moistened by the acid, but as the manganese is gradually dissolved, it descends until all of it is acted on. The cover of the large opening has a hole in it, with a lead tube adapted to it for carrying off the chlorine. These decomposing vessels are introduced in groups of four into a rectangular chamber of masonry, open at the top, which is afterwards covered with boards on which dirt is thrown; steam is made to circulate around the vessels, and they are heated as high as 90° Cent.; by this process six or seven per cent. of the acid remains undecomposed. In Lancashire large vessels are used made of six thick Yorkshire slabs joined by grooves at the edges, luted with a cement that will resist heat, and bound by bands of India-rubber, and held together by iron bolts and nuts. They have the necessary openings for charging and cleansing, and are of very large dimensions, taking for a single charge from four hundred to eight hundred pounds of oxide of manganese. They are heated by steam, and the gas is carried off first by lead pipes, and, as the gas cools, by gutta-percha tubes.

DUNLAP'S PROCESS OF MAKING CHLORINE.

Reference has been made to Dunlap's method of forming chlorine for manufacturing purposes, without oxide of manganese. I will give Hofmann's description of it, as he saw it carried out at the works of Tennant & Co., of Glasgow. It consists in decomposing a mixture of chloride

of sodium and nitrate of soda by means of sulphuric acid. The products of the reactions are chlorine, nitric acid, and sulphate of soda; the two volatile products being separated and employed respectively for the manufacture of chloride of lime and sulphuric acid.

The operation is conducted in large cast-iron cylinders lined with bricks set in coal pitch. These cylinders are five or six feet in diameter, and from seven to eight feet in height, capable of holding half a ton of nitrate of soda and a ton of common salt, together with the quantity of sulphuric acid necessary for the conversion of the nitrate and chloride of sodium into sulphate. The vessels are heated over a naked fire to a temperature varying between 200° and 250° C.; in thirty-six hours the reaction is complete. The gases as they leave the apparatus consist of chlorine and nitrous acid, with a little hydrochloric acid; these are conveyed into large leaden vessels, containing sulphuric acid to the height of about two feet. These acid holders are placed one after the other, and the gases are compelled to pass through them successively under a considerable pressure. The sulphuric acid absorbs the nitrous acid, and when sufficiently charged, is employed in the leaden chambers to furnish directly the nitrous acid to the sulphurous acid, the nitro-sulphuric acid being thus advantageously employed, the remaining mixture of chlorine and hydrochloric acid then passes into a small condensing tower full of coke moistened with water. The hydrochloric acid is thus retained, when the purified chlorine passes on to the chloride of lime apparatus. The residue of bisulphate of soda in the cylinders is either employed to decompose the nitrate of soda in the preparation of nitric acid, or else cast into the sulphate of soda furnace with chloride of sodium, from which it expels hydrochloric acid, being itself converted into neutral sulphate of soda.

The above method of Dunlap is only used by the Messrs. Tennant & Co.

SCHLOESING'S PROPOSED METHOD OF MAKING CHLORINE.

The proposed improved method of Schloesing is based on the fact that when peroxide of manganese, prepared by heating nitrate of manganese, is acted on by a mixture of hydrochloric and nitric acids at a certain degree of concentration, the application of heat produces chlorine and red nitrous fumes; below this point of concentration the mixture may be heated to ebullition without giving off anything but chlorine, the nitric acid combining with the protoxide of manganese to form the nitrate, and the hydrochloric acid alone is decomposed, furnishing chlorine. The practical operation is accomplished by using nitric acid containing 50.5 grams of anhydrous acid to the litre, and hydrochloric acid containing 397 grams of hydrochloric acid to the litre, mixing these acids in the proportion of four equivalents of nitric to four equivalents of hydrochloric acid, and adding to the mixture one-seventh of its volume of water.

The nitrate of manganese formed is decomposed by heat at 190° C.,

the decomposition is rapid, and the nitrous acid formed may be passed into sulphuric acid chambers, or reconverted into nitric acid by contact with air and water. The reaction appears to be a very pretty one, but as yet has not been put into practice.

OTHER METHODS OF PRODUCING CHLORINE.

There is a method recently proposed in Belgium, by first converting sesquioxyde of iron into the sulphate by the direct action of sulphuric acid, then mixing this sulphate of iron with three equivalents of chloride of sodium, heating the mixture in dry air, when chlorine is evolved.

Laurens's method has been revived by M. Mallet, viz, *producing chlorine from chloride of copper.* He proceeds as follows: Upon protochloride of copper heated to 100° or 200° C., commercial hydrochloric acid is slowly dropped, steam alone will be disengaged, and supposing the addition of acid to be slow enough and the access of air and renewal of surface sufficient, the odor of hydrochloric acid will be scarcely perceptible, and the whole protochloride will be transformed into anhydrous bichloride, which, when heated in a close vessel, instantly disengages chlorine, with the reproduction of protochloride that can be again put through a second, third, or any number of processes with but small loss of the original matter. In this way 100 kilograms of chloride of copper can be made to produce from 200 to 300 kilograms of chloride of lime, in twenty-four hours. The price of the raw material does not exceed one franc the kilogram. This process, although not yet in practical operation, has evidently a future application.

There is also another process, having a promise of good results hereafter, the formation of chromate of lime by the *action of the oxide of chromium on lime* at a red heat, and the subsequent action of hydrochloric acid on this chromate, when chlorine is formed; the reproduction of oxide of chrome from the residue, by treatment of the solution with milk of lime, and the reaction a second time, and so on.

All these processes, while they do not yet compete with the oxide of manganese process, show that we have not anything to apprehend from the rise in the price of oxide of manganese.

USES OF CHLORINE—CHLORIDE OF LIME.

This element, although applicable to so many useful purposes in the arts, from its gaseous nature, cannot be stored away, as *chlorine*, for transportation. Fortunately, hydrated lime becomes a convenient and cheap medium by which it can be condensed, and, by subsequent operations of a very simple character, made to develop its useful properties. The chloride of lime formed by this process is so well known, and the process of its manufacture is so thoroughly described, that very little will be said upon it, especially as there was nothing special connected with its manufacture brought out by the Exposition.

LIME FOR MAKING CHLORIDE OF LIME.—It is probably not well under-

stood how important it is to select the proper kind of lime for the manufacture of chloride of lime. A pure lime is not the best; a small quantity of silica and alumina in the lime is an advantage, from some unknown cause, and the limestones of some localities are preferable to those from others. There is no better way of ascertaining the best quality for this purpose than by direct experiment. There is a certain quality of limestone near Rouen, in France, so well adapted to this purpose, that the vessels from England, bringing coal to Rouen, take back to Newcastle this limestone, to be used by the manufacturers there.

CONDENSING CHAMBERS.—The forms of chambers used for combining the chlorine with the lime are various, although lead chambers are coming more and more into use; but there is none better than the one very commonly employed in England, viz, chambers in the open air, constructed of bricks, cemented, and made solid and substantial, with a roof that sheds the water during rain. The floor of the chamber is covered with slacked lime to the depth of about seven inches, with a height of eight or nine feet to the ceiling, which is slightly arched; there are glass windows in it, to examine the operation, and to judge by the permanency of the yellow gas that the chlorine is no longer absorbed. The lime is never agitated, and the operations are carried on slowly, and last during four days. There are two large openings that are well closed with wooden doors, covered with pitch, and are opened at the end of the operations to drive out the excess of gas, and to withdraw the lime, or introduce casks, that in winter time, during the bad weather, are filled inside of the chamber.

SPONTANEOUS ALTERATION OF THE CHLORIDE OF LIME.—It unfortunately happens that this compound undergoes more or less alteration by time, which is accelerated by an elevated temperature, producing chloride of calcium and chlorate of lime. Something analogous to this sometimes takes place in the chambers. At 100° C. chloride of lime will liberate chlorine and oxygen; the temperature, however, in the chambers seldom exceeds 50° C. A very rapid introduction of the chlorine may raise some parts to 100° C., but this is rapidly cooled down by the contiguous lime, so that no injury to the lime may ensue. It sometimes happens that after the chloride of lime is packed violent reactions take place in the interior of the mass, raising the temperature far above 100° C., decomposing the chloride to such an extent as to render it useless. It generally happens that chloride of lime of this character will indicate its true character if properly inspected before packing.

The causes of this decomposition are not understood, but those who exercise certain precautions never suffer loss in this way. These precautions are: First, the chlorine gas is thoroughly cooled, thus condensing moisture and hydrochloric acid. In certain English works this cooling is accomplished by passing the chlorine through a tube several hundred yards long. Second, incomplete hydration of lime. To avoid this, never use the lime the day it is slacked, but let it lay over two or three days.

Some of the best-directed establishments never use the slacked lime under eight days, and then even bolt the lime. When these two precautions are observed, there is no fear of failing to make an unalterable chloride of lime.

UTILIZATION OF THE RESIDUE OF THE MANUFACTURE OF CHLORIDE OF LIME.

The residue of the manufacture consists of chloride of manganese with a little free hydrochloric acid. When this last is neutralized by lime it can be used with great advantage in disinfecting cesspools, &c. It has also been used by Kuhlmann to form chloride of barium, by acting on the natural carbonate of baryta. This chloride is subsequently employed for furnishing sulphate of baryta, which is largely used, mixed with soluble glass, for a certain style of painting. It has also been proposed to precipitate it by lime and form balls out of the mass, and mix with iron ore to form spiegel iron, now used so largely in the formation of steel by Bessemer's process.

But the most important use to which the residue is put is the reproduction of the peroxide of manganese. The first operation in this case is to form the carbonate of manganese; this is done by using the milk of lime, adding just enough of it to neutralize the excess of acid and precipitate the peroxide of iron that is contained in the solution. After the liquor has been well agitated and subsequently settled, it is pumped into a large cylindrical boiler that can be perfectly closed and has an agitator. To this a milk of finely divided carbonate of lime is added in sufficient quantity to precipitate the manganese, carefully avoiding an excess. The boiler is closed, and heat applied, either by fire or steam, until the pressure in the boiler reaches two to two and a half atmospheres. In about twenty-four hours the operation is complete, and a white precipitate of carbonate of manganese is formed; the precipitate is washed, pressed, and dried on iron plates. The conversion of the carbonate into peroxide is effected by placing the carbonate in shallow sheet-iron vessels upon wagons that are run upon rails into vaulted galleries of brick-work. At the establishment of Messrs. Tennant & Co., of Glasgow, the galleries are large enough to hold forty-eight of these wagons. The galleries are heated from the outside, and are raised to a temperature of 315° C.; a current of air traverses the galleries, under the influence of the heat that increases as the wagons descend. The manganese loses its carbonic acid, and the oxygen of the air combines with it, care being taken to sprinkle the manganese with water as it descends in the galleries. After remaining about forty-eight hours, the compound contains eight-tenths pure peroxide of manganese and two-tenths of lower oxygen compounds of manganese, and is said to rival in efficiency the native oxide. This process has not been generally adopted, because the apparatus and manipulations are expensive and the native oxide is usually cheap.

Another utilization of the residue is to evaporate it to a sirup-like con-

sistency and mix with it nitrate of soda—79 parts of chloride of manganese to 106 of nitrate of soda. This mixture, dried at a moderate temperature and heated in iron cylinders to a low red heat, evolves nitrous fumes, which may be used in the sulphuric acid chambers. The residue consists of peroxide of manganese and chloride of sodium, which can be employed directly in making chlorine, but this has not given very satisfactory results in practice.

Paul Buquet, director of the works at Dieuze, Kopp, and others have applied the chlorine residue to the reproduction of sulphur from soda residue. This industry has been fully reviewed in the chapter upon sulphuric acid; but it is proper to give some details of the process as carried on in the establishment of Dieuze, where the chlorine residue is employed for this purpose. It consists in making as intimate a mixture as possible of the soda residue and a small quantity of the chlorine residue, deprived of its free acid by lime; seven or eight litres are sufficient for 100 kilograms of soda residue. There is a sulphide of manganese first formed, which, in contact with the air, is decomposed, forming oxide of manganese and sulphur, which last combines with the sulphide of calcium.

At Dieuze the mixture alluded to above is placed in a large heap of about 400 cubic feet, the height being about six feet. The reaction commences in about three days after the turning up of the mass; heat is developed, and the mass dries, when it must be sprinkled to keep it moist. At the end of six days in summer and nine days in winter they proceed to lixiviation in large brick basins, with a false bottom pierced with holes. The mass is well washed, and the washing and filtrate so managed that by passing through a series of vats, alternately, a saturated solution is obtained of polysulphide of calcium, with but a very little hyposulphite. The insoluble portion in the vats is exposed a second time to the air and relixiviated; this contains also polysulphide of calcium, but with a large excess of hyposulphite. These two solutions are called "yellow water;" the first, however, goes by the name of "yellow sulphur water," and the second "yellow oxidized water." These are both decomposed by the chlorine residue containing protochloride of manganese, perchloride of iron, and free hydrochloric acid, in large stone-ware basins, the joints of which are luted with pitch. Both solutions must be clear when brought n contact. The first action by the free acid is to precipitate sulphur, which becomes more or less mixed with sulphide of iron and other impurities. At this point no more of the yellow water is to be added; this is known by the solution becoming black with the sulphide of iron. The precipitate is raked out and used in making sulphuric acid, or purified, when every cubic yard yields about 100 pounds of sulphur. Second, the manganese liquor is still continued to be treated with the yellow waters until the precipitate formed is no longer blackish, but has the flesh tint of sulphide of manganese, when the liquor is allowed to repose and the pure manganese liquor is drawn off clear. The yellow water is further

added until the precipitation of the manganese is complete, the precipitate here being sulphur and sulphide of manganese. The only residues that are now to be thrown away are those left by the first lixiviation, not deleterious, and chloride of calcium, which is also innocuous. The mixture of sulphur and sulphide of manganese, equivalent to 58 per cent. of sulphur, can be burned directly in the sulphur furnace of the sulphuric acid chamber. It must be dried carefully and used at once, as it is apt to ignite spontaneously from the decomposition of the sulphide of manganese. From the combustion, sulphate and some of the lower oxides of manganese are produced. Some application has been made of these substances, but the results, while promising, have not, as yet, amounted to any good practical success. The oxides, however, are quite pure, and can be used by glass-makers and others.

At Dieuze the system of apparatus is complete and perfect, and they now regularly recover 36 per cent. of the sulphur used in their chambers for producing sulphuric acid. This and similar triumphs of the skill and perseverance of the chemists of the present day give a clear idea of what the industrial arts are to expect from them in the future.

Besides making chloride of lime, the industrial uses of chlorine are limited. It is used to make chlorate of potash, in the manufacture of which there has not been any improvement since the well-known method of Graham was devised of forming chlorate of lime. It is also used in making per-chloride of tin.

GENERAL REMARKS ON THE EMPLOYMENT OF SODA AND CHLORIDE OF LIME.

These two substances are intimately associated with the wants of civilized society. The soda furnishes glass and soap, and other necessaries of life. The chloride of lime is now absolutely necessary for nearly all bleaching operations, and its use in paper making increases every day. The use of these two substances mark in some sense the progress of civilization. In England the quantity of salt used in making soda and chlorine in 1867 was 400,000 tons, and for the same year in France 107,000 tons; and the soda salts of 80° produced cost in London $42 the ton, and in Paris $52.

FLUORIC AND FLUOSILICIC ACID.

The production of these acids on an industrial scale formed a somewhat prominent feature in the development of the chemical arts as brought out by the Exposition of 1867. Up to the present time fluoric acid and the compounds of fluorine have had only a limited application in the arts; but M. Tessié du Motay and others have recently done much to extend their use.

The experiments of Tessié du Motay are based on the decomposition of fluor spar mixed with silica and carbon, and the formation of fluoride of silicon. The manner of conducting the operation is to make a mix-

ture of fluor spar, silica, and alumina in such proportions as to form a slag similar to that formed in an iron blast furnace, and to add to this a suitable quantity of carbon in the form of powdered charcoal or coke. This mixture, slightly moistened, is made into bricks, which are dried in an oven, and are afterwards, with a sufficient quantity of coke, thrown into a blast furnace thirty or forty feet high, already heated up by coke. As the charge descends it is decomposed by the heat, the silica and fluoride of calcium are decomposed, the carbon aiding by abstracting oxygen from the silica, the resulting compounds being fluoride of silicon and silicate of calcium; the former passing off in the form of gas, the latter uniting with the alumina, and running off in the form of a slag. Thus nearly all the fluoride of calcium is decomposed, the balance passing off with the slag. A properly arranged apparatus is placed above the mouth of the furnace in order to collect the gas, which is conducted into a series of five condensing chambers constructed of wood and containing a large number of plates of glass inclined like Venetian blinds and moistened by the sprinkling of water on the surface, which decomposes the fluoride of silicon, forming silica, which is deposited in the bottom of the chamber, and fluosilicic acid, that is dissolved by the water. The water supplied to each chamber is taken from the chamber just below in the series; thus number five supplies number four, and number four supplies number three, and so on; this is done for the purpose of concentrating the acid as much as possible, which, however, never goes above 10° Baumé, and more commonly not above 5°. The acid thus made costs four times the price of its equivalent quantity of sulphuric acid. This acid is doubtless calculated in time to be applied to many useful purposes in the chemical arts; it has been for some time employed in making chloric acid from the chlorate of potash, for compounding with other bases to be used in the pyrotechnic art. The most extensive purpose had in view in its recent production on a large scale, is to decompose the chloride of potassium, (now so abundant,) and the formation of the insoluble fluosilicate of potash. To accomplish this, a saturated solution of chloride of potassium is made in wooden vats, and 100 litres of fluosilicic acid of 5° Baumé is added for every seven kilograms of the chloride of potassium in solution. A bulky precipitate is formed of fluosilicate of potash, which is separated from the water that now contains hydrochloric acid, and is collected on felt filters and finally on heated bricks. Thus prepared, it is introduced into commerce and sells in France at ten cents per pound. It is often used in the place of borax, and can be substituted for it in making flint glass. It can also be used for the formation of caustic potash, by first decomposing it in gas retorts by applying heat. Fluoride of silicon is driven off, and can be condensed for another operation, and fluoride of potassium remains behind, which can be decomposed by lime or its carbonate, forming caustic potash, or carbonate of potash, and fluoride of calcium, that can be used in a subsequent operation. This process can be applied to soda

salts also; and Tessié du Motay has commenced the manufacture of these compounds on a large scale.

The use of fluorine compounds has been considerably developed by the same inventor, in connection with M. Maréchal, in *engraving on glass;* fluoride of an alkali with sulphuric acid being employed to engrave glass without destroying the polish, and employing a hydrofluate of the fluoride of silicon when a dead surface is desired: these methods of furnishing the hydrofluoric acid are but a modification of known processes. We are doubtless to expect something in the future from the introduction of these compounds in the arts. Already cryolite, the natural fluoride of aluminum and sodium, is being largely applied in the manufacture of an opaque glass, and it is desirable to present, in some detail, an account of the process as described in the American Journal of Pharmacy, May, 1868:

GLASS FROM CRYOLITE.

"The application of cryolite to this new porcelain or opaque glass promises to be one of those discoveries, simple in themselves, that may materially affect the course of trade and manufacture. This material (which is simple glass, so far as the mode of working is concerned) is furnished at less than the cost of the cheapest ordinary white or flint glass. It can be worked or formed with the facility attending working common brown or pressed glass, and any article of any shape that can be made from glass can be made from it, and the product exactly resembles the finest French porcelain in appearance and beauty, but far surpasses it, as well as glass, in toughness, strength, and capability of standing sudden changes of temperature. The ingredients used in its manufacture consist of cryolite 10 pounds, white sand 20 pounds, and oxide of zinc 5 pounds; the dirty discolored oxide, worth less than half the price of the white oxide of commerce, answers very well for this purpose. The infusion of the ingredients is effected at the same heat, and in the usual manner practiced in the flint-glass factories. In this manner can be made not only the articles ordinarily made of glass or porcelain, but also tiles, mantel-pieces, moldings, statuary ware, mortars, pill tiles, evaporating dishes, funnels, ointment jars, and, in fact, any and everything capable of being cast, blown, or molded whilst in a melted state, and at a mere trifling cost. The business of making these articles from cryolite is as yet in its infancy. One establishment in this city alone, [Philadelphia,] and the only one yet in operation, is working exclusively on it, consuming from 500 to 1,000 tons of cryolite per annum; but its use will necessarily become general, either as a specialty or in connection with the ordinary white or transparent glass. Having obtained from the factory of this 'hot-cast porcelain' several mortars, funnels, and evaporating dishes and tested them fully and satisfactorily, they were found to have their advantages over the ordinary ware now in use. The mortars presented at all times a much whiter color, and withstood more pounding

or trituration than the Wedgewood mortar commonly used; and the evaporating dishes resisted the heat of both the sand and water baths; at the same time we were able to purchase them at about one-half the cost of ordinary porcelain. Not only these bulky and useful articles are manufactured, but also the finest parlor ornaments and lamp shades are made and decorated, and finished in a most beautiful manner, at the establishment which is situated in the upper part of Kensington, on York avenue, in Philadelphia."

MANGANESE COMPOUNDS.

Until comparatively recently, the natural compounds of manganese were only to be seen in industrial chemistry, and were used for the manufacture of compounds requiring a certain supply of oxygen. In 1862, the visitor to the London Exposition saw the manganates and permanganates produced on a large scale by several chemical factories; this arose principally from M. Condy's successful introduction of these substances as powerful disinfecting agents, especially in rendering water charged with organic matter, and even fœtid, fit to drink, all that was necessary being to introduce a small quantity of a solution of these salts until the water was permanently but slightly colored by the salt.

The present Exposition furnishes us with the important results of M. Tessié du Motay in forming manganate of potash or soda by passing air over a mixture of oxide of manganese and the caustic alkali. This has been used for forming oxygen cheaply and on a large scale; and it will be referred to in another part of the report.

MANGANATE OF POTASH, USED IN BLEACHING.

In many instances in bleaching tissues, even after the successive treatment of the alkalies and chloride of lime, exposure to the action of light is requisite. In this, as well as in all other cases, the result can be immediately accomplished by the permanganate of soda; the operation is as follows:

Mix green manganate of soda with a certain quantity of sulphate of magnesia. This can be dissolved when required, as it furnishes a red solution—the permanganate; into this the tissue required to be bleached is immersed for from four to ten minutes. It is now withdrawn, and has a brownish color, arising from precipitated peroxide of manganese; it is washed by immersing it in a weak solution of sulphurous acid, which reduces the deutoxide of manganese with the formation of the sulphate of manganese; it is subjected to this operation two or three times, when the tissue becomes perfectly white. If the practical operation of this process proves a success, we will have another most important step in the art of bleaching.

CARBONIC ACID.

This acid, so abundant in nature, has not occupied a conspicuous position in technical chemistry, principally from the fact of its being a feeble

acid. It is, however, coming more into use for certain operations. Convenient and cheap methods are therefore sought for forming it more or less pure, as in making aerated waters and getting rid of the lime in the defecation of sugar.

CARBONIC ACID FROM THE COMBUSTION OF COAL.

It can be produced by passing air over incandescent coal, or by heating limestone, or by acting on the carbonates with the strong acids. The former is, however, the method most commonly employed for making it at the sugar factories, and is considered the cheapest. Coke or charcoal is burnt in a close furnace, and the gaseous matter resulting from the combustion is washed by passing it through water, and ultimately introduced where it is required. The acid thus made of course contains a large amount of nitrogen. Very recently we have a method proposed by M. Ozouf, which furnishes the gas quite pure; it is based on the capacity of a solution of carbonate of soda to absorb carbonic acid and to disengage it when heated.

OZOUF'S PROCESS.

Air which has been passed over ignited coal by means of a pump is driven through a solution of carbonate of soda, and after the absorption ceases, this soda is introduced into a kind of still and heated; pure carbonic acid is driven off; the solution returns to its original condition, and is ready to be recharged with carbonic acid.

The apparatus is said to be costly, amounting to about $6,000 or $8,000, but it can produce carbonic acid at a cost of two cents the cubic yard. It is said to be already used in the manufacture of white lead and aerated waters.

CHAPTER VI.

INDUSTRIAL PRODUCTION OF OXYGEN, HYDROGEN, AND OTHER ELEMENTS.

OXYGEN AND ITS PREPARATION ON A LARGE SCALE—PROCESS OF DE MOTAY—HYDROGEN; ITS PREPARATION BY GIFFARD'S PROCESS—PHOSPHORUS AND ITS COMPOUNDS—FRICTION MATCHES; INCREASE OF FIRES CONSEQUENT UPON THE USE OF—PHOSPHATE OF POTASH AND PHOSPHATE OF SODA—BROMINE; ITS INCREASING IMPORTANCE IN TECHNICAL CHEMISTRY—IODINE; IMPROVEMENTS IN THE PROCESSES FOR PRODUCING—SODA-NITRE BEDS OF PERU A SOURCE OF IODINE.

OXYGEN.

Ever since the composition of our atmosphere was clearly understood, it has always been a problem among chemists to obtain the 21 per cent. of oxygen contained in it in a pure state, so as to render it more available for the vast variety of purposes to which it might be applied. There have been various manufacturing processes devised by Boussingault, by St. Claire Deville and Debray, by Tessié du Motay, Maréchal, and others; one using baryta, and depending on the absorption of oxygen at one temperature and the liberation of it at another; the second looking to the decomposition of sulphuric acid by heat into oxygen and sulphurous acid; the third, the absorption of it from the air by a mixture of oxide of manganese and soda at a certain elevated temperature, and the liberation of it by the action of super-heated steam; also from the oxychloride of copper.

The oxide of manganese and soda process at the present time is more likely to become an industrial process than any other. Until recently we have not had any reliable information as to the cost of production of oxygen in this way. M. Tessié du Motay is, however, prosecuting his experiments with a good deal of perseverance, aided by capital; and I have no doubt of its ultimate success. The only application that has yet been made of it is for illuminating purposes, in conjunction with coal gas, by heating a cylinder of magnesia or zirconia, forming a Drummond light. There have been a good many practical difficulties in the way; some have already been overcome successfully, and the others will be made to succumb to the ingenuity of the age. It has also been applied to bleaching, which process was exhibited by M. Tessié de Motay, and is thus described by the correspondent of the Chemical News.

PROCESS OF DE MOTAY.

The fibers, threads, and tissues contain two sorts of coloring matters—one soluble, after oxidation, in alkaline lixivia; the other substances

inherent to the cellulose, which should be bleached by the oxygen of the air and light, or by chemical compounds able to disengage oxygen in its nascent state.

The methods hitherto employed for bleaching or decolorizing tissues depend upon the alternate application of two sorts of agents:

1. Oxidizing substances; 2. Solvents.

But these methods, perfect as they are in their way, have the following faults: The employment of an oxidizing agent which acts with extreme slowness when it is taken from the atmosphere, or with a destructive combustible power when it is several times placed in a medium containing chlorine or the chlorated compounds, such as the hypochlorites, for example; the use of alkaline solvents, which act with extreme slowness in dissolving the quantity of coloring matter altered by the oxidizing agents. For these latter the most suitable substitutes are: 1. Permanganic acid, produced by the decomposition of the permanganates by means of hydrofluosilicic acid. 2. The alkaline permanganates, with the addition of chlorides, sulphates, and alkaline fluosilicates capable of forming salts, having for base permanganic acid, at the moment when this acid is decomposed by the fibres passing themselves into a basic state, as is shown presently.

In order to employ practically the oxidizing agents and solvents above mentioned, the operation is thus:

"For bleaching stuffs or threads of cotton, linen, or hemp, all the grease or fatty matter is extracted by an alkaline bath. They are then steeped in a solution of permanganic acid or permanganate of soda, with the addition of sulphate of magnesia. Afterwards (15 minutes interval generally) the substances to be bleached are removed and transported either into alkaline solutions or into baths containing sulphurous acid, nitrosulphuric acid, or peroxide of hydrogen. In the first place the substances are heated to the boiling point in alkaline solutions for several hours, until the oxide of magnesia, which covers them, is partially or wholly dissolved. In the second case the substances to be bleached are steeped in baths containing sulphurous acid, or nitrosulphuric acid, or oxygenated water, until the layer or oxide of manganese, with which they are coated, is entirely dissolved; after this they are washed and resteeped, first in a solution of permanganic acid or the permanganate, afterwards in alkaline solutions or in the solvents above mentioned, and so on till the bleaching is completed. A bleaching bath containing, according to the nature of the fibers or tissues to be bleached, from two to six kilograms of permanganate of soda, is sufficient to bleach effectually 100 kilograms of cotton, hemp, or flax, raw or woven."

This method of bleaching is the same for wool and silk, except that the alkaline liquid is a weak solution of soap, and the sulphurous acid is alone employed.

"The industrial results obtained in the factory of M. Verlay, at Comines, by the above-mentioned process, show that hemp and linen

threads are completely bleached, without alteration, in one day; that their tissues are bleached in three days; that the cost for complete bleaching is on an average seven cents the kilogram for threads, and $1 25 per 100 meters for the woven stuffs.

"By the present methods of bleaching, even the most rapid and economical, all textile substances or tissues threads require, according to the daylight and weather, at least 15 days, and at most 30 days; tissues, from 30 to 60 days. Also the cost of bleaching, on the other hand, amounts in similar cases to about nine cents per kilogram for threads, and $2 per 100 meters for tissues."

In order to obtain the practical result which we have just mentioned, new economical processes were necessary to be found:

1. The production of manganate of soda; 2. To transform this manganate into permanganate.

Lastly, we mention that manganate of soda is now prepared and sold at the rate of twenty cents (in France) per kilogram to bleachers.

Its transformation into permanganate is easily and cheaply made, either by means of sulphate of magnesia, chloride of magnesium, or chloride of calcium.

HYDROGEN.

The industrial production of hydrogen gas has also become a matter of considerable interest, and various methods have been devised for making this element cheaply. M. Giffard brings forward a new process, by decomposing water with coke, and converting the oxide of carbon thus formed into carbonic acid by the agency of a second application of steam, increasing the original amount of hydrogen. The water is condensed, and also the carbonic acid, leaving the hydrogen nearly pure. The method is thus described:

GIFFARD'S PROCESS.

"The gas is produced in a sort of furnace charged at the back with coke, divided by refractory stones at the front into a great number of channels, which are traversed by gas. When the fire is well lighted the sides of these channels attain a red heat, and the coke is uniformly red throughout its thickness, which is considerable. Then the damper is shut, the ash-pit closed, and a jet of steam is made to play on the under surface of the coke. By traversing this mass of coke the steam is decomposed, producing carbonic oxide and hydrogen gases.

"At the upper part of the boiler there are nine small jets of steam, which pass through the carbon and mix with the hydrogen and oxide of carbon as far as the red-hot channels, where a new reaction takes place. The carbonic oxide is more highly oxygenated at the expense of the steam, and is converted into carbonic acid gas, while the hydrogen is set at liberty. The system of tubes is very ingeniously contrived; the tube which unites the two boilers and supplies the four cylinders is prolonged

on the opposite side is case of need. Two tubes, which start from the principal trunk, conduct the jets of steam which pass over the coke, and those which traverse it for the production of gas. Two other tubes, called blowers, leading to the ash-pit and the chimney, assist the combustion by jets of steam. The second produces a reversed draught, in order to produce a downward combustion. Lastly, two groups of tubes, furnished with and controlled four ways by cocks, conduct the steam to two cylinders, the object of which is to open and shut, one the ash-pit door, and the other the damper of the chimney. The gas on quitting the generating furnace is necessarily charged with much steam, and it passes into tubes kept constantly surrounded by cold water, changing continuously, which condenses the greater part of the steam; the water of condensation falls into the bottom of a sort of vertical tubular boiler, transformed into a refrigerator, and is let out by a discharge cock. The gas then passes through a lime purifier, in which it is desiccated before it arrives at the bottom. The purifier is a large case of strong boiler plate, with a man-hole at top for introducing the lime, and a grating at the bottom, on which the lime rests and beneath which the gas passes. At a small distance above the grating there are movable plates revolving on their axes. In the ordinary position in which they are placed, vertically on their edges, the gas enters by interstices similar to those of a venetian blind. But when the lower part of the lime is exhausted, the plates are turned horizontally; they then form a floor, on which the unslacked lime rests. The production of gas is intermittent. When the steam has in part extinguished the coke and cooled the sides of the refractory stone, the admission of the steam is cut off, the ash-pit and damper closed, then one or other of the blowers are set in motion, and the operation of gas-making commences."

This has not yet received any application in the arts.

PHOSPHORUS AND ITS COMPOUNDS.

There is nothing new in regard to the industrial production of this element further than this, that the production of the ordinary as well as the amorphous phosphorus is more abundant, and the article is cheaper, than it was five years ago. Its great use is still in the manufacture of friction matches, the consumption of which is enormous.

FRICTION MATCHES.

In France 200,000,000 of matches are used daily, and this represents an annual consumption of more than 12,000,000 of kilograms of wood, or about 50,000 cubic meters. In some countries a proportionally greater quantity of matches is consumed, and the annual consumption of wood in Europe for the purpose is probably more than 500,000 cubic yards of wood.

Austria has the largest factories, some of them employing as many as 5,000 hands. The largest in France is at Marseilles, employing 600

hands; and the entire number of men so employed in Europe is certainly over 50,000, furnishing products having a value of $50,000,000.

No great progress has been made in the manufacture and safety of this article. A great effort is made to abolish the use of chlorate of potash, and retain the best quality of the match; this is done very successfully by some manufacturers, but others do not pay much regard to it.

With the introduction of this most convenient article into every-day life the number of fires has increased nearly 100 per cent. Accidents through the agency of children have increased as much as 400 per cent., and criminal incendiarism as much as 80 per cent.

In France matches cost the insurance offices about $600,000 annually.

The phosphorus matches are also dangerous to health and life, and they are not unfrequently used for committing suicide. Those manufacturing them are also exposed to serious injury to the health; good ventilation of the factories can, however, obviate this last objection.

To overcome most all of the objections to this article, amorphous phosphorus, now so well known, should be resorted to. Many manufacturers have used this form, but it has not been much encouraged by consumers, and some manufacturers who employed special surfaces for rubbing their matches on are abandoning it. This is to be regretted, but it should not prevent the industrial chemist from making efforts to overcome the objections.

PHOSPHATES OF POTASH AND SODA.

Specimens of these compounds, made at Javelle, in the establishment of M. Fourcade, were on exhibition. The process adopted is a new and cheap one, invented by M. Boblique.

The source of phosphoric acid is in the nodules obtained near Ardennes, and now found so extensively in various parts of the world. The manner of operating is as follows:

To 100 kilograms of the nodules (containing silica 31, lime 28, phosphoric acid 19, phosphorus, &c., 8 per cent.) is added 60 kilograms of an iron ore found near the phosphate deposit, containing about 24 per cent. of water and a silicious and chloritic gangue. The mixture is melted in a blast furnace, resulting in the formation of a phosphuret of iron with 20 per cent. of phosphorus, and a slag containing the other ingredients.

The phosphate of soda is prepared by melting, in an ordinary soda furnace, a mixture of 100 parts of the powdered phosphuret of iron, 200 parts of dried and crushed sulphate of soda, and 30 parts of fine coal. The material is worked and raked during the fusion. When the operation is complete, and the mass is fused, it is run into cakes weighing 1,200 or 1,400 pounds each. Exposed to the air for a few days, it crumbles, and is then subjected to a systematic treatment with water, which dissolves out the tribasic phosphate of soda. This is crystallized and

sent into commerce. The sulphuret of iron and sodium remaining is burnt, and the sulphurous acid is used in the sulphuric acid chamber; the soda is converted into a sulphate, which is washed out from the oxide of iron, and can be used again; so that neither sulphur nor soda is lost in the operation.

BROMINE.

This substance is becoming of more and more importance in the technical arts and in medicine than it formerly was. For many years it was doubtful whether or not its compounds were of any therapeutical value; this is now no longer in doubt; and, while it cannot replace iodine and its compounds, it nevertheless has important uses in the treatment of disease. In the production of some of the so-called coal colors it is already being applied, and its use in this direction will be increased with the diminution of its cost.

The source of bromine is the same as it always has been, viz, the mother water of salines, from which it is easily extracted by heating the mother water to its boiling point, 125° cent., allowing it to flow into a sandstone retort of 200 to 400 gallons capacity, such as is used in making chlorine, having two openings in the cover, one for conducting off the vapor of bromine, and the other, with a tube plunging beneath the liquid, for introducing oxide of manganese and sulphuric acid. The manganese should be soft and of the best quality, and should be boiled in water before being introduced into the retort, so as to expel adhering gaseous matter that is apt to interfere with the regularity of the decomposition. A jet of steam is introduced into the mixture, when bromine is evolved, and is condensed in a proper cooler of glass or earthenware. The operation is continued so long as the vapors of bromine are given off by the addition of oxide of manganese and sulphuric acid, when the still is emptied and fresh materials are introduced. It is more commonly preferred now to add the sulphuric acid to the mother water before introducing it into the still, as sometimes considerable effervescence is produced, and it is an object to prevent this taking place inside the still. The mother water of proper density yields about four pounds of bromine to every 100 gallons of water.

Formerly the great bulk of bromine in commerce came from the manufactory of Schœnbeck, but since the working of the chloride of potassium at Stassfurt very large quantities are produced there, as much as 21,000 pounds per annum, of which the establishment of M. Frank makes about one-half. As in a preceding portion of this report it has been stated that these beds at Stassfurt are almost inexhaustible, with a likelihood of discovering others in other parts of the world, we may expect a gradual diminution in the price of bromine.

Owing to the great risk of sending the liquid bromine into commerce, it is now largely converted into bromide of ethyl, which is readily packed and safely transported. M. Frank converts a large proportion of

the bromine he manufactures into this compound, by mixing bromide of potassium, alcohol, and sulphuric acid, and then distilling. The bromine can be readily reproduced from this compound.

IODINE.

In the manufacture of this substance there are small improvements made from time to time. Messrs. Cournerie formerly conducted all their evaporations over the naked fire; they now carry them on by means of steam, and consider that they have economized the production of this important substance.

M. Moride, who carries on extensive operations on the island of Noirmoutiers, burns a portion only of the sea-weed; the remainder is stretched about the fire and carbonized. This carbon is leached, and the residue is mixed with turf and used as fuel. The inhabitants conduct this operation of carbonization, and sell the material to the manufacturer. In this way 2,000 bushels of this carbon are produced weekly.

The lixiviated solution is concentrated by steam, and the mother water produced, after separating the bulk of the salts, is treated with sulphuric acid strongly nitrous, and the iodine is precipitated. Coal naphtha (boiling at about 120° C.) is now added, and the mixture is agitated, when the naphtha takes up the iodine. This last is now agitated with a solution of soda, and the iodine is separated from the naphtha, which is ready for another operation, as the naphtha does not now contain iodine.

Recently much attention has been drawn to the soda-nitre beds of Peru as a source of iodine, it having been shown, more than ten years ago, that the iodine existing in the mixture was in the form of an iodate. The iodine is obtained by pouring a solution of sulphurous acid or the bisulphite of soda into the mother waters, which precipitates the iodine as a black powder. When the exact proportion of reagents is employed, if there be an excess, the iodide is formed and the iodine is lost; if not enough, the iodate is not decomposed, and is also a loss.

The mining company of Tarapaca produces 200 tons of nitre, and an equal quantity of mother water containing one two-thousandths of iodine. This company, by imperfect treatment, extract only eighty-five pounds of iodine daily. Other works are now looking also to the production of iodine, and when the manipulations are improved a very much larger quantity will be produced; and as these nitre beds will furnish nitre for a great number of years, this source of iodine is important, and deserves careful consideration.

CHAPTER VII.

MANUFACTURE OF ILLUMINATING GAS FROM COAL, AND THE UTILIZATION OF THE WASTE PRODUCTS.

COAL, AND ITS EFFECT UPON THE DEVELOPMENT OF THE ARTS—MANUFACTURE OF GAS; IMPORTANCE AND EFFECTS—MATERIALS USED—RETORTS AND FURNACES—GAS CONDUCTORS AND CONDENSERS—METHOD OF HEATING THE RETORTS—DISTRIBUTING PIPES—EXHAUSTERS—GAS METERS—GAS BURNERS—COLLATERAL USES OF GAS—PORTABLE GAS WORKS—NEW FORMS OF ILLUMINATING GAS—THE CHEMISTRY OF GAS-MAKING—THE GAS WORKS OF PARIS—UTILIZATION OF THE WASTE PRODUCTS OF THE MANUFACTURE OF COAL GAS—COKE—AMMONIACAL LIQUORS—COAL TAR, ITS COMPOUNDS—SPENT OXIDE OF IRON—REFUSE LIME—ABSORBENTS OF AMMONIA—COAL TAR COLORS—VIOLET COLORS—ANILINE REDS, BLUES, GREENS, AND OTHER COLORS—THEORY OF THE FORMATION OF COLORS—CARBOLIC ACID COLORS—NAPHTHALINE COLORS.

INTRODUCTION.

There is not any substance which, in the last forty or fifty years, has produced such wonderful results in the development of the arts, commerce, and industrial pursuits, as coal. It is not, however, our province here to refer to its applications in metallurgy and the other arts in which direct operation brings about the required results; but to confine this and the following chapter to the industrial products obtained from coal by operations more or less indirect.

I had drawn up a report based on the results as exhibited in Paris in 1867, but it was so extended and hastily digested that it has been discarded, and in its stead I have combined my report on gas and gas materials, as made out for the jury reports published by the Imperial Commission, with the admirable lectures of Dr. Letheby on the articles made from coal, and have appended an extract from the report of Dr. Hofmann.

GAS AND GAS MATERIAL.

PROGRESS OF THE ART OF GAS-MAKING.

Important progress has been realized in the manufacture of gas—more, however, in reference to giving stability, and to perfecting apparatus already employed, than in the discovery or application of anything new. The importance of this industry is manifesting itself every day, not so much in the direct products for illuminating purposes, already so well established, but from the great number of valuable and beautiful products resulting from the treatment of the residues by the chemist.

We have become so accustomed to the use and production of illuminating gas from coal that, like most things we are habituated to, the

great value of the product and the importance of the industry, as well as everything else connected with it, is lost sight of alongside of more glaring and recent discoveries of far less magnitude; yet if we review the origin and development of this industry, and the direct and indirect effects of it upon the advancement of the age, it is certainly to be ranked as one of the most important inventions of the present century, and second only to that of the steam-engine.

Its direct effect is to convert night into day, to make the short and obscure winter days equal to those of summer, giving more time to those occupied with in-door pursuits, and enabling them to conduct their labors with less fatigue to the eye and with more certainty of execution. In this aspect alone the immense wealth that has been added to the industrial arts is incalculable.

In its indirect effects, the use of coal gas has benefited society by saving vast tracts of land for other agricultural purposes that would have to be devoted to the cultivation of plants furnishing oil and fatty matters to be used for illumination; and besides, there have been saved for other purposes hundreds of ships and thousands of seamen that would be required for the whale and other fisheries carried on simply for the purpose of procuring oily matter to be used for furnishing light.

Regarded as a luxury, its benefits are not to be despised, for it has cheapened many of them to such a degree that both rich and poor are equal participants of them. Our brilliantly lighted streets are evidence of this fact, so that the people traverse our cities with the same ease and security at night as in daytime. And here we may again allude to another fact in connection with the manufacture of coal gas, namely, that the offensive residues which are the natural result of gas making have been made to give rise to most important industrial pursuits, employing a large amount of capital and accumulating wealth. Coke, ammonia, pitch, and tar have been for many years drawn from this source; but it has been left for the more recent developments of chemistry to extract from the tar, by processes more or less indirect, beautiful crystallized compounds used in giving to silk, woolen and cotton, colors that rival in brilliancy the hues of the rainbow; and this discovery in its turn reacts on the manufactures of the various textile fabrics. All of these facts will be most fully developed in the report on coal colors, by Professor Hofmann, to whom we are indebted for the first and most important steps in their manufacture.

It is not the design or province of this report to go into the historical details of the origin and development of this industry. Like many other great discoveries, the world was prepared and looking for it. The minds of many were occupied with it, and the distinguished Scotch philosopher, Dr. Chalmers, "at a time when the streets and lanes of all great cities were lighted with oil burnt in lamps, held that the time was not distant when a carburetted-hydrogen gas would be substituted instead, and on getting his house repaired he actually introduced into the walls of the

house a system of tubes and pipes for the passage into the various rooms of the gaseous fluid yet to be employed as the illuminating agent." But among all the vague speculations and ingenious devices, there were two individuals endowed with skill and practical minds, who were giving shape and form to them—Murdock in England, and Le Bon in France. The combination, however, of circumstances favored the former, and I think no impartial investigator of the subject will fail to render to William Murdock, of Redruth, Cornwall, the sole merit of the practical application of coal gas to the purpose of artificial illumination, in about 1800. And it is a noteworthy fact that this discovery was first exhibited publicly as a rejoicing over the hush of war and the renewal of peace, on the occasion of the grand illumination in England commemorative of the peace of Amiens, in 1802.

Since the commencement of the century to the present time the industry of coal gas has been gradually improved, and the mixed nature of this compound has been more and more simplified, rendering the illuminating gas better adapted for the purposes to which it is applied; the condensable products and impurities are better removed, and the latter, in their turn, made to subserve some useful purpose, until the gas manufacturer receives the coal from the mines and sends forth nothing that is useless.

In a systematic review of the gas industry and products resulting therefrom, so far as regards its more recent improvements exemplified by the great Exposition of 1867, the remarks will be confined especially to what was there exhibited.

MATERIALS USED FOR MAKING ILLUMINATING GAS.

The Exhibition does not furnish anything new under this head. To sum up what is now known can be done in a few words.

The materials now used in the manufacture of gas may be comprised under the following articles: coal, wood, pitch, rosin, oils, fats, and petroleum. There are also other vegetable and animal products which have been suggested, and even employed, on a small scale, as bones, &c. But of all the raw materials there are none which can compete with coal, except under some extraordinary combination of circumstances; for not only does coal furnish gas more economically, but it affords valuable residues, producing the fuel necessary for its formation in much larger quantity than is required for that purpose, and other important refuse matter, as tar, ammonia, &c. The question in regard to the substitution of petroleum for coal is not worth serious consideration at the present time. It may be advantageous occasionally to add, in a convenient manner, some petroleum when this is abundant and the coal used requires the addition of a material to furnish gas of a high illuminating power; then from twenty to thirty gallons of petroleum to 2,000 pounds of coal may become desirable. Pitch and rosin, when cheap, may be added to coal for the same purpose. All other adjuncts, as vapor of water, &c., serve

only to dilute the gas and make it of less value. Bituminous coal, under its various forms, has not found a rival, nor is it likely to encounter any for a long time.

The following fact may be mentioned in connection with the manufacture of gas from wood. In those countries where this material is abundant and coal is not accessible, wood, aided by the addition of some substance furnishing a rich hydro-carbon, may be made to furnish a very useful illuminating gas, and an economical one, especially when the residue in the retorts and the material distilled with the gas can be rendered serviceable. In Coburg, Canada, it is said to have been used advantageously, furnishing a good gas and a valuable residue, viz:

Two parts pine wood.
One part hard wood.
One part bones.

The residue in the retorts is an excellent charcoal for bleaching purposes, and the other residues are quite serviceable. Where bones cannot be obtained, offal and other coarse animal matter can be used to mix with the wood. This suggestion is worthy of consideration, especially for many small towns peculiarly situated.

RETORTS AND FURNACES.

These are the first and most essential parts connected with gas-making; and the present Exposition is rich in specimens of these from various countries. In the Belgian department, we have the fire-brick, tiles, and retorts from "La Société anonyme des terres plastiques et produits refractaires d'Andennes," a company employing nearly 20,000 tons of clay annually, requiring about two hundred and twenty men, and having thirty-two large kilns. Among the articles exhibited by this company are very large retorts, one of which is over ten feet in length and two feet across, with an opening of about seventeen inches, and two inches thick; it weighs about 1,700 pounds, and is of most excellent manufacture, which is equally true of all other articles exposed by the company. Near the above are to be found the retorts of Sugg & Co., of Ghent, who supply, to a very large extent, the gas works of Germany. From Prussia there are excellent products of fireclay, made by Vygen & Co., of Duisburg, and used in Germany, Holland, and Switzerland. England is represented by the well-known products of Cliff & Son.

France furnishes retorts and gas ovens of excellent quality; there are several exhibitors, but none are so conspicuous as those from Bosquet & Co., Lyons, and from the Paris gas company. The retorts from the former establishment are covered with a kind of black enamel, and are set in the gas ovens by being simply supported at the two ends. Without further investigation, I should doubt the advantage of this style of setting; its simplicity may be too great a sacrifice to its security.

The black enamel here referred to is composed of—

Galena	54
Silicious sand	24
Oxide manganese	15
Iron scales	7

It is said that this is put on to render the retorts less sensible to variations of temperature.

There is, however, no establishment so thoroughly organized or confining itself strictly to the refractory materials necessary for gas ovens as the Paris gas company, about which it may be well to make a few detailed statements, as the plan of operation of this company may be advantageously followed by other large gas companies. The works of this company are at La Vilette, a place most conveniently located for the purpose, as railroad and canal communications bring all the necessary materials to this point, and it is on the same premises as the extensive gas works of that locality. It has been established since the consolidation of all the gas works of Paris, about twelve years ago, and it furnishes retorts and other refractory materials required by the different works in Paris and in many other parts of France. The mills, mixers, &c., are set in motion by a forty horse-power engine; but all the manipulations, after tempering the clay, are performed by the hand, requiring about forty men for the purpose, as no machinery has yet been devised to replace successfully the use of the hand in giving the necessary uniformity of consolidation to the plastic material employed in making the retorts and the large tiles, that are constructed by compacting together the materials in small lumps, using for that purpose the blows of an iron hammer or wooden mallet.

The articles manufactured at the Paris gas works annually are:

Retorts	3,000
Blocks and tiles	20,000
Bricks	1,000,000

All the burning of the above is accomplished in furnaces heated by coke.

It is an interesting fact connected with this establishment that there is no refuse rejected; for even the ash of the furnace is used to make a tile for the floors of its own work-rooms, and their excess is sold outside for similar purposes, for stables, &c. The ashes are mixed with a common clay, the cinders being pulverized; the mass thus formed is very dense, and is slightly vitrified. It is said to replace very advantageously the pavements of workshops, now commonly made in brick—about fifty per cent. of ashes being used.

Among the articles exhibited by this company are large pieces of refractory materials—one of a perfect tube ten feet long and forty-three inches in diameter, and one solid mass of eighteen tons for the floor of an oven. There is a small model of their gas-oven complete, with retorts, &c.

In the above statement in regard to gas retorts there is nothing new that has been developed in the past five years. It simply shows that the old iron retort, originally used, is more and more thoroughly excluded than ever from gas works; for, while a clay retort may require a little more fuel than an iron retort, this is more than compensated for by its original cost and durability, and the possibility of using a higher temperature, one better adapted to the generation of gas, viz., 1,200°, which cannot be employed with an iron retort.

As regards the manner of setting the retorts in the ovens different plans are proposed by different engineers, each having their advocates. In London, gas ovens are often made with ten retorts eighteen feet long and open at both ends, each retort being composed of three pieces. In Paris, the retorts are of a single piece about nine feet long and open at one end, and in each oven there are six or seven retorts. We understand that in London there is a tendency to give up the ten-retort system, and not to exceed six or eight to an oven; regularity of temperature and facility of emptying the retorts would recommend the latter.

The system of through settings with double mouth pieces is very much objected to by some gas engineers. Henry Gore, in a paper read before the British society of engineers, says: "In large works, and with clay retorts, the system of through setting, with double mouth-pieces, is unquestionably the most economical, both as regards fuel and durability. But this arrangement is open to grave objections. If the retorts are used for the generation of gas of high illuminating power, the increased surface over which the gas passes after it is eliminated from the coal exposes it to the chance of decomposition, and the consequent deposition of its carbon. That this goes on to a very great extent is evident from the amount of solid carbon, or graphite, found on the inner surface of the retorts. In through retorts this deposition is due mainly to two causes: in the first place, in charging the retort with coals either by the scoop or shovel the center of the retort scarcely ever receives its due portion of coal, and as this part is always the hotest, it follows that the gas generated from the thinner stratum of coal is exposed to intense heat, and a portion of it is decomposed, liberating the hydrogen and depositing the carbon, thus forming a deposit which rapidly increases and soon renders the retort useless, unless precautions are taken from time to time to remove the carbon. Another cause of this deposit is the want of uniformity in the pressure in the two hydraulic mains; a slight resistance in one main or the other causes the gas to take the course offering least obstruction, and as the particles of gas thus pass over a large amount of heated surface, they are exposed to the greater risk of decomposition. Several expedients are suggested to remedy this evil; one is to use a valve to each ascension-pipe, so as to dispense with the dip-pipe when the retort is working; another is, to have only one hydraulic main, placed over the center of the ovens, and both mouth-pieces connected to it by a single dip-pipe."

CONDUCTORS OF GAS FROM THE RETORTS, CONDENSERS, ETC.

Under this head we obtain no new suggestions in the present exhibition. In the gas works visited all the conductors of the older parts have been too small, their dimensions being based on calculations made in reference to gas unmixed with thick, condensible vapors in suspension. This is, however, avoided in all new constructions. In some works, instead of a hydraulic main to every row of benches, only one is used for those ovens worked back to back, this being placed in the center line, the hydraulic main being constructed of sheet-iron three-eighths of an inch thick, to avoid risk of breakage from irregular settling and expansion. All these points are worthy of consideration. In condensers there has not been any striking or useful novelty in recent years, and nothing at the exhibition suggests any.

METHOD OF HEATING THE RETORTS.

All that is novel under this head is the application of Siemens's gas oven and regenerative furnace to this purpose. There is a model of this furnace in the Exposition, and, as its application is of a general character and is already well known, I leave to other reporters all that is to be said concerning it. As regards its applicability in heating gas retorts, this has been successfully carried out at the Vaugirard gas works, at Paris, and the gas works in Birmingham, England.

The experiments made at Vaugirard were with a single generator applied to heat sixteen ovens of eight retorts each, and there has been found a saving of from twenty-two to twenty-nine per cent. of fuel, and the results have been sufficiently satisfactory to encourage the Paris gas company to adapt it to other works when needed to be refitted.

PIPES FOR DISTRIBUTING GAS.

In several of the classes there are exhibited pipes for this purpose. There are cast and wrought iron pipes, bitumenized paper pipes, bitumenized sheet-iron pipes, copper, lead, brass, vulcanized caoutchouc, and a new material, called parkesine, in the English department. As most of these pipes will be reported on by others, only a few remarks will be made with special reference to their use in gas distribution. Cast-iron pipe is still used in most countries for the distribution of gas through cities. In France, however, they have been more or less abandoned, although it is a question if this can be done advantageously.

The exhibition of cast-iron pipes from the various countries is certainly magnificent, but the beauty of the French castings is not excelled and is rarely equalled. There are some new plans proposed for joining the pipes—one by M. Marini called the universal joint, made with rings of caoutchouc and cast-iron bands; but it is doubtful if any joint made with caoutchouc is to be relied on for any length of time, where gas is to be conducted, and where naphtha and other condensible products will be constantly acting on the joint.

WROUGHT-IRON PIPE.

The specimens of these pipes on exhibition merit a special notice by the proper reporter on the subject. Those intended for conducting gas have no special merit beyond those of former Expositions. The use of these pipes in conducting gases through houses is very limited in France compared with their similar use in England, America, and other parts of the world; lead and composition pipes supplying their place. Other purely metallic pipes used in conducting gas present nothing novel. The specimens of lead pipes show to what great perfection their manufacture has been developed, and there seems to be no limit to the length which can be given to a single pipe. One specimen on exhibition is 8,000 feet long.

Caoutchouc pipes show no improvement in quality of composition. They are all permeable to gas, which defect can, however, be more or less perfectly remedied by two or three coatings of boiled linseed oil applied to the external service, a precaution that will render the use of this conductor, especially in chemical laboratories, far less offensive. Parkesine is an artificial composition for gas pipe, and it is said can be substituted advantageously for caoutchouc. It is to be found in Class 44 of the English department, and is said to be made of gun-cotton and other chemical compounds. Bituminous pipe is on exhibition, and is recommended for conducting gas. It is stated that it is used in some places for this purpose; but the well-known action of certain of the constituents of gas on bitumen would naturally militate against its use.

BITUMENIZED IRON PIPE.

Under this head there are gas pipes exhibited by Messrs. Chameroy & Co., of Paris. While these pipes are no recent novelty, yet they deserve especial notice, as the manufacture of them has received during the past few years a wonderful extension, for the purpose of conducting water as well as gas. The base of the pipe is sheet-iron, leaded, varying in thickness according to the required size and pressure; each section of pipe is made of two sheets, that are first riveted together separately with tinned rivets, and plunged into a bath of melted lead; these two pieces of pipe are then riveted together, and the junction of the two well tinned. The entire pipe is now thirteen feet long. On the ends are cast convenient sockets and spigots, made of a mixture of lead and antimony, and these serve to unite the sections of pipe when laid in the ground. The exterior surface of the pipe is coated with tar, and around this is wrapped a cord; this cord is then covered with melted pitch, and the pipe then rolled in coarse sand until it has acquired a thickness of from one-fourth to five-eighths of an inch.

In attaching a service pipe to these pipes when used as main pipes, it must be done by soldering a lead or composition service pipe to the main, in order to make a good and effective junction.

It is impossible for the reporter on this article to form a correct opinion upon the merits of this pipe as a conductor for gas. In lieu of this, a statement will be made of the statistics of the products of the works of Messrs. Chameroy & Co. In one year was made one hundred and fifty-five miles of pipe, for gas, from one and three-quarters to twenty-eight inches diameter; the Paris gas company have in ten years laid four hundred and thirty-six miles of these pipes. In the exhibition building there is nearly one mile from twelve to twenty-four inches diameter, and since the foundation of the establishment in 1838 the products of the works have been as follows:

	Miles.
France, for gas	2,577
France, for water	664
In other countries, for gas	583
In other countries, for water	233

Entire value of the above, $7,708,400.

There is an objection in using this pipe, arising from accidents to it that may happen when excavating near them, as the point of a pick can be driven into them without producing disturbance enough to make the accident evident at once, but which may subsequently give indications by leakage, causing serious accidents; one of which occurred recently in France.

EXHAUSTERS.

For many years the adoption of exhausters has been considered a matter of economy in all large gas works; but more especially, since the introduction of clay retorts, they have become an absolute necessity. There is nothing new exhibited in the way of improvement in gas exhausters, and the opinions of engineers are still divided between the use of exhausting cylinders and rotary exhausters. Schiele, of Frankfort, exhibited a rotary exhauster, said to work well, and very economical in its original cost. In Paris, an exhauster with three cylinders, devised by M. Arson, is employed in the gas works. One of these exhausters has been for eight years in continual use. Brochi exhibited one consisting of three small gas-holders, with their bottoms plunged in tar, and worked alternately by one of Hugon's gas engines.

GAS METERS.

We find on exhibition both wet and dry meters. The wet meter is the one most commonly in use on the European continent. In France there are but few dry meters employed, and consequently there has been a good deal of attention given to the improvement of the wet meter.

One of the modifications of this meter, as made by the celebrated manufacturers MM. Brunt & Co., is that the "syphon and regulator are bent in a vessel having a vertical tube which enters the waste-water box. The tube is separated by a diaphragm from the inside of that box, on

which the spindle of the drum turns; the meter thus fulfills the following conditions prescribed by the administration of gas in Paris and other parts of France:

"The examiner, having left all the orifices of the meter open, shall ascertain that the float, the syphon, the hydraulic seal of the vertical shaft, and the inlet pipe for the water, are water-tight under a pressure of at least four inches."

Other French exhibitors, as Messrs. Siry, Lizars & Co., and M. J. Williams, show most perfect workmanship in their apparatus, the latter manufacturer paying a great deal of attention to testing apparatus. Almost every European nation is represented by gas meters; and England, the greatest of all gas-consuming countries, is, as might be expected, fully represented with everything in the way of meters, both wet and dry, which are active competitors for the ascendency in England. The dry meters of MM. George Glover & Co. are as complete as they can be made with our present knowledge, and are world-renowned for their accuracy and durability. The wet meters of the Globe Meter Company are well arranged for adjustment of water level, and are said to require adjustment but once a year. There are other makers who arrive at the same end by different means.

The compensating meter of Messrs. Sanders & Donavan, of Dublin, accomplishes this by an independent compensation float, not interfering with the machinery of the apparatus. In the articles exhibited by the gas meter companies of London, Oldham, and Dublin, there is a pressure generating meter, in which a spring or weight, as in a clock movement, is made to increase the pressure, a desideratum in some instances where the street pressure is not sufficient. The first meter to which is attached the movement draws in gas say into a ten-light meter; from this it passes to a ten-light dry meter, and then through a five-light wet meter of variable level.

Many of the English meters are now made with cast-iron outer casing instead of tin plate. There are various large station meters exhibited, that have all possible care bestowed on their construction; but there is no novel feature in any of them worthy of special mention.

GAS-BURNERS.

As the chief use of coal gas is to be burnt for the purpose of affording light or heat, it is only second in importance to the economical production of gas to obtain the greatest amount of light from a given quantity of gas; yet while there is continual attention given to this subject, but little advancement has been made during the last few years. This arises from the fact that the circumstances under which gas is burnt are so variable that no one rule is applicable in all cases. The unavoidable variation of pressure at the works and in the main are irregular, variable quantities; so are the differences arising in different stories of the same building, and other well known causes.

The only principle by which it is to be expected that a burner will regulate itself to the differences of pressure is by the use of a movable diaphragm and conical valve like that used on the governor at the gas works. Messrs. Suggs, of London, and others in different countries and at different times, have adopted this principle, and Suggs's regulators may be seen attached to many of the street lights in London. They are still far from being perfect, and this arises from the necessarily diminutive nature of the regulating adjustment.

There are some regulators which can very advantageously be attached to the gas pipe as it enters the building prior to its distribution. The one on exhibition by M. Henri Giroud deserves special consideration, while at the same time it is far from filling all requirements; but, with the occasional superintendence of some one attending specially to the business, much gas might be saved to the consumer. The same inventor exhibits what he calls a *telegraphic regulator*, upon the same principle as the smaller regulator, but which can be attached to the main pipes in any part of their distribution; and, by a system of return pipes, electrical and clock movements, these irregularities are made sensible to the governor at the gas works, which opens or closes the valve of the main regulator and establishes the proper equilibrium between the pressure at the works and that in the main pipes. A thorough explanation of this apparatus would require several drawings and more detail than can be given in a report like this. It has been in practical use in several places, and is well spoken of.

But, after all, an attention to the cocks once or twice in the evening is the simplest and most economical way for private consumers to regulate their consumption of gas. This, however, cannot be applied very conveniently in the public lights; so there is much yet to be done in furnishing a proper regulator to be applied to each lamp, either just under the burner or at the base of the lamp.

The form of the jet through which the gas issues prior to being ignited is of the utmost importance to produce the best effect. Those now in general use are three: the *bat-wing*, a burner with slit; the *fish-tail*, or Manchester burner, with two oblique openings in the end; and the *argand*, a circular burner with a number of small holes. The only investigations upon the best form for burners, the results of which are to be found in the Exposition, are those of MM. Audouin and Berard, (the former connected with the Paris gas works,) and have been conducted with the utmost skill and ability.

It is of importance to furnish in some little detail the results of these experiments as they bear particularly on public lights; no reference will be made to the preliminary experiments bearing upon the method of experimenting, or the photometric arrangement. The carcel lamp, burning forty-two grams of oil per hour, is the term of comparison; as the agreement between the city of Paris and the gas company is that from twenty-five to twenty-seven and a half litres of gas, under a pressure

of from two to three millimeters of water, must furnish a light equal to that of a carcel lamp burning in the same time ten grams of purified colza oil.

The first set of experiments was made with the *bat-wing* burner, with a round extremity connected with the main part of the burner by a short, broad neck. A variety of these burners was made. They varied in the diameter of the button and the width of the slit, and the experiments with them gave the following results:

1st. That the maximum effect of illumination corresponds to a slit of seven-tenths of a millimeter.

2d. In comparing a tip having one-tenth of a millimeter with one having seven-tenths with the same quantity of gas, the latter gave an illuminating effect more than four times as great as the former; consequently, the same quantity of gas can give, when it burns in a good tip, four times more light than when burnt in a bad one.

3d. That the intensity increases more rapidly than the increase in the width of the slit.

4th. That the augmentation of illuminating power corresponds to a very rapid diminution in the pressure, and consequently to a diminution of the flow of gas during the combustion; and that for each series of burners experimented with, the maximum corresponds to a flow measured by a pressure of two to three millimeters.

The experiments in relation to the dimensions of the buttons at the end of the burners showed that as the dimensions of the buttons became greater the flame became less steady and had a tendency to smoke. That for every given consumption of gas there was a button of a given diameter, that produced the best effect, using a slit of seven-tenths of a millimeter, which, as has already been observed, gives the most advantageous results; the diameter of the button employed in Paris for the slit above mentioned, which is the one now used, is seven millimeters.

Although the results of the experiments have led to the use of the *bat-wing* burner in public lights, it is as well to state the results of MM. Audouin and Berard in relation to other burners. As to the *fish-tail*, or Manchester burner, it was shown that it should be burnt with a pressure of at least three millimeters; if this were not the case, the two jets of gas would not encounter each other with sufficient force to spread the flame. The diameter of the holes for the maximum of illuminating effect is comprised between one and seven-tenths to two millimeters, but it is necessary for holes of this size to consume about two hundred litres of gas. For the consumption of one hundred to one hundred and fifty litres of gas per hour the diameter of the holes should be about one and a half millimeters. The *Argand burner*, which consists of a circular ring pierced with small holes, is much in use for private illumination, especially in Paris, and the study of this burner was a matter of considerable interest, and the result of the experiment was that the differences of intensity were due, 1st, to the diameter of the holes; 2d, to the number

of holes; 3d, to the distribution of the air; 4th, to the height of the glass chimney. As regards the size of the holes, a diameter of seven-tenths of a millimeter is considered the most advantageous; as to the number of the holes, a large number was considered advantageous—thirty being a convenient number, a feeble pressure giving the best effect for the same amount of gas. A cone to concentrate the air on the flame is useful, and the best height for the glass chimney was twenty centimeters. The advantages in illuminating effect increase indefinitely with the amount of gas consumed, and can be carried even to the point at which the flame passes the glass, when of course further increase becomes impracticable. All of these statements in reference to this burner have reference to its equaling the illuminating effect of a carcel lamp burning forty-two grams of oil an hour.

The same experimenters have shown that when it is required to illuminate a large space it is best to increase the size of the burner, as by that means the maximum effect is obtained from a given quantity of gas; and the city of Paris has adopted one giving the effect of three and one-half carcel lamps with a consumption of only three hundred and sixty litres of gas. It is a *bat-wing* burner, with the diameter of the button of fifteen millimeters and a slit of six-tenths of a millimeter.

MATERIAL FOR TIPS OF BURNERS.—These are made either of metal or earthen material. Of the metals, iron, brass, and various compositions are used. The earthy materials are lava, porcelain, soapstone, and artificial compounds resembling these. There is nothing new under this head, except that great progress has been made in the manufacture of burners of every form and description from these earthen materials, and they are likely to replace to a considerable extent those of metal, as the small openings are not as liable to be stopped up by the action of the air as the metallic ones are.

COLLATERAL USES OF GAS.

In various departments of the Exhibition are to be seen a variety of uses to which gas is applied besides that of illumination. Lenoir, Hugon, Otto & Langen have developed its use as a motive power by igniting a mixture of air and gas in cylinders. For domestic uses, as that of cooking, it has received a very extensive application, and can be employed economically under a variety of circumstances. Stoves, large and small, of various devices, are to be found, especially in the English and French departments. It is also used largely by the workers in metals, for the purpose of soldering, and various other manufactures where a conveniently regulated and an intermittent source of heat is required. The chemist in the laboratory for analysis and research uses gas to the exclusion of almost all other sources of heat, and a great variety of convenient and ingenious arrangements for their use are to be found in the German, French, and English departments. There is,

however, no really novel form of apparatus on exhibition. Some remarks on its application as a motive power will be found in another report.

PORTABLE GAS WORKS.

There are several on exhibition, but they represent nothing of noteworthy novelty. MM. L. Coignard & Co. exhibit small gas works, on the plan of M. G. Jonanne, for the purpose of using all substances capable of furnishing illuminating gas. In the English department there are several compact and economical gas works from two or three makers. Mr. George Bower makes gas works furnishing six to eight lights for four hours at the price of $110.

NEW FORMS OF ILLUMINATING GAS.

For many years various efforts have been made to impregnate air with the vapor of the light hydro-carbons, and igniting the vapor thus suspended as it passes through burners similar to those used for ordinary gas. Under some circumstances very good effects are produced. But variations of temperature interfere with the regularity of the light, and in places where public gas works exist they cannot be brought into use, even if it should be shown that the consumption of material to produce a given illuminating effect is less expensive than the cost of the public gas, for certain manipulations are necessary which are incompatible with the nature of service to be found in private houses.

THE CHEMISTRY OF GAS-MAKING.

The progress made in the knowledge of the chemistry of gas-making deserves special consideration, not only in regard to the manufacture and purification of the gas, but the utilizing of the waste products. Under this head I will merely make a statement in regard to the operations of the Paris gas works, and in doing so there is no injustice done to other gas works, for none of them work up so thoroughly the waste products.

GAS WORKS IN PARIS.

In 1856 all the gas works in Paris were amalgamated into one, conducted by a private company, which supplies Paris and all its suburbs for six or seven miles outside of the fortifications of the city, which last have a circumference of about twenty miles. In 1856 the annual consumption of gas was 1,671,746,970 cubic feet. In 1866 it had increased to 4,320,491,244 cubic feet, and the capacity of the works is sufficiently great to supply five billions of cubic feet of gas per annum. There are 71,836 private consumers, and 32,232 public lights. To produce the amount of gas required, the works used, in 1866, 421,000 tons of coal.

"The coke produced in 1866 by the Paris gas company amounted to 613,626 chaldrons, part of which was consumed in the gas works, and the remainder sold to the public. To facilitate the sale of the coke, the

company manufactures stoves specially adapted to heating by this means, and sell them to the public at a very moderate price. The heating by coke offers so many advantages, that from the 1st of January, 1858, to the 28th of February, 1867, the Paris company sold to private individuals alone 16,909 of these stoves. The quantity of tar produced from the distillation of coal amounted last year to 21,540 tons. To facilitate the disposal of this product the company are obliged to distil a large portion of it. Of the 21,540 tons produced in 1856, they distilled 20,074 tons, which yielded 13,600 tons of pitch, at the price of from $1 50 to $2 per 220 pounds, the substance being used in the manufacture of patent fuel and artificial asphalts. They obtained, besides, 524 tons of light oils, and 3,660 tons of heavy oils. The former have been sold as benzine for scouring clothes, for painting, and in caoutchouc manufactures, or they have been converted into nitro-benzine or aniline. The production of nitro-benzine amounted to 133 tons, and that of aniline to 1,327 pounds. With regard to the heavy oil, (creosote,) it has been sold to the dealers in wood, and has been almost entirely employed in the impregnation of railroad sleepers. A certain quantity of this heavy oil has been purified and used as a lubricator and in common painting. The tar oils always yield an appreciable quantity of phenic acid, which, in a liquid state, is of use for disinfection, and when crystallized, for the making of picric acid; and it is used in medicine. The purification of gas supplied last year about 3,000 tons of ammoniacal products, either in the form of sulphate of ammonia or volatile alkali. A certain quantity of sulpho-cyanide of ammonia has also been obtained from the products of the condensation of gas. The waste materials used in the purification of gas have been purchased by the manufacturers of Prussian blue; but as the residuals contain not only sulpho-cyanides and cyanogens, but also a considerable quantity of sulphur in a free state, the company have treated a part of them by a special process, and have obtained a material which contains from fifty-five to sixty per cent. of free sulphur, which may be employed in manufactures or in agriculture. It will be seen from these results that the company have turned to good account the residual products of the distillation of coal."

The gas of these works is most thoroughly purified, and the dealers in silks and other delicate fabrics, who, a few years ago, always suffered more or less loss from the results of the combustion of the impure gas acting on their fabrics, now no longer suffer from that cause. The purification of their gas, as that of a great many of the large establishments in Europe, is effected by the oxide of iron, which, although a little more costly than lime, has the advantage of being readily restored for repeated uses, and avoids the accumulation of that most disagreeable of residues—gas-lime. My observation, however, leads me to believe that the purification by oxide of iron had better be aided by the wet lime process. Much more might be said on the present condition and requirements of gas-making, but to do so would exceed the expected limits of this report.

UTILIZATION OF THE WASTE PRODUCTS OF THE MANUFACTURE OF COAL GAS.[1]

The residual products of gas-making are six in number—namely, coke, ammoniacal liquor, coal tar, and the three waste products from the purifiers, as the spent oxide of iron, the refuse lime, and the acid or other matters used for absorbing ammonia, each of which has its special value on account of its technical uses.

I.—COKE.

This need not occupy much of our attention, as its practical value and uses are pretty well known to you. I may say, however, that it was the opinion of the late Dr. Fyfe, and is still the opinion of many chemists who have examined the power of coal under steam-boilers, that the heat actually made available in practice is very nearly the same as ought to be produced according to theory by the quantity of coke which the coal yields. He found that a pound of Scotch coal from Trenant would boil away 5.61 pounds of water, and that the coke of it, which amounted to 0.525 of a pound, produced 3.9 pounds of steam; so that the practical loss was $5.61 - 3.9 = 1.71$ pounds; but the theoretical value of the coke was about 5.5 pounds of steam. Here is a table of the relative heating power of different fuels, expressed in the number of pounds of water which one pound of the substance will boil away when the water has been heated to its boiling point:

	Pounds.
Dry wood (average of many specimens)	4.51
Derbyshire coal (ditto)	7.58
Scotch coal (ditto)	7.70
Lancashire coal (ditto)	7.94
Newcastle coal (ditto)	8.37
Welsh coal (ditto)	9.05
Good coke (ditto)	10.00

If all these numbers are multiplied by 5.5, they will give the quantity of water which a pound of the fuel will in each case raise from 32° to 212°, and the results show that the thermotic power of coke is very high.

II.—AMMONIACAL LIQUOR.

This is the aqueous portion of the condensed products of the gas. It floats upon the tar, and is a watery solution of carbonate, sulphide, and sulphocyanide of ammonium, with certain carbohydrogens of no value.

If all the nitrogen contained in coal were converted into ammonia, so as to make a liquor of eight ounces strength (4° Twaddle,) it would yield from 142 to 226 gallons per ton of coal. This will be evident from

[1] From a lecture delivered before the British Association of Gas Managers, by Dr. Letheby, and communicated by the author to the *Chemical News*.

the table which is before you, and which represents the average amounts of nitrogen in certain well-known coals in a dry condition:

Varieties of coal.	Nitrogen per cent. in coal.	Ammonia per cent. from coal.	Gallons of liquor of 4° Twaddle per ton of coal.
Welsh coal, (average)	0.91	1.10	142
Lancashire coal, (average)	1.25	1.52	196
Newcastle coal, (average)	1.32	1.60	206
Scotch coal, (average)	1.44	1.75	226

But by far the largest portion of nitrogen is not converted into ammonia, for by combining with sulphur and carbon it forms the sulpho-cyanides which are so abundant in ammoniacal liquor and in spent lime, and much of it also unites with carbon and hydrogen to produce the alkaloids which exist in the tar. In practice, therefore, you get but a comparatively small proportion of the nitrogen as ammonia in the ammoniacal liquor. The quantity of liquor rarely exceeds forty-five gallons of eight-ounce strength per ton of coals; and to obtain this quantity you must condense well, and also wash the gas with water. I have already explained to you how this is done at the Birmingham and Staffordshire gas works, by Mr. Hugh Young, who obtains forty-four gallons of liquor per ton of Staveley coal in his yearly working. In ordinary practice the yield is about twenty-five gallons per ton, and in London it is not above thirteen gallons—calculated in every case as eight-ounce liquor. You will see from this how largely the production of ammoniacal liquor may be increased; and I will call to your recollection the valuable advice of your president, Mr. Hawksley, with respect to the copious washing of raw gas with ammoniacal liquor, for this practice has a twofold advantage—it not only purifies the gas by removing tarry matter and sulphur compounds, but it also strengthens the liquor and renders it a more valuable product. By using the liquor as a shower or in a scrubber, in the proportion of one volume of liquor to sixteen of gas, the liquor may easily be raised to 10° or 11° of Twaddle, which are equivalent to from twenty to twenty-two ounces of acid; and considering that the price of liquor rises about 4*d.* or 6*d.* per butt for every degree of Twaddle, it is manifestly of the greatest importance that the liquor should be sent away from the works as strong as possible. It ought, in fact, never to be under 6° of Twaddle, or of less than twelve ounces strength; and, with proper condensation and judicious washing, there should be from twenty-nine to thirty gallons of such liquor produced from every ton of coals. The average price of ammoniacal liquor of eight ounces strength in eleven towns of England is at the present time 2*s.* 7*d.* per butt of 108 gallons. It ranges from 1*s.* 9*d.* to 4*s.* 6*d.* per butt, and in London it fetches 2*s.*, with an increase of 4d. per butt on every additional ounce of acid

strength. Below 3° of Twaddle or five ounces of acid it does not pay for working, whereas at 10° or 11° of Twaddle it is a valuable product. The strength of the liquor may be estimated either by the hydrometer or by the quantity of strong sulphuric acid (sp. gr. 1.845) required to neutralize it; and it will be found that every degree of Twaddle is equal to about two ounces of acid per gallon of liquor.

The method of converting the liquid into a salt of ammonia varies in different places according to the facilities for working. In some places the liquor is at once saturated either with sulphuric or muriatic acid, in a close tank, and the evolved gases (sulphuretted hydrogen and carbonic acid) are carried to a furnace or to a furnace shaft. The saturated liquor is then evaporated and crystallized in open troughs. This, however, produces a dark-colored salt which is not very salable. The liquor, therefore, is either distilled alone from a steam-boiler, or it is mixed with lime in the boiler, so as to fix the sulphuretted hydrogen and carbonic acid, and is then distilled. In many works the liquor is heated in an apparatus called a Coffey's still, which is a tall vessel containing a number of transverse divisions (from twenty to thirty) which alternately pass to nearly the opposite sides of the vessel. The liquor is run in at the top, and as it flows from side to side over the alternate divisions, in its way downward, it meets a rush of steam, which is admitted at the bottom of the vessel, at a pressure of from twenty to thirty pounds upon the inch, and thus the carbonate and sulphide of ammonium are volatilized. In all these cases the ammonia is distilled into a close vessel containing sulphuric acid, diluted with enough water to prevent the salt from crystallizing, (equal parts of brown chamber acid of commerce and water are good proportions;) and the evolved gas (carbonic acid and sulphuretted hydrogen) is conveyed to the furnace fire, or is used for the production of oil of vitriol. When the ammoniacal liquid is evaporated by blowing steam into it, it is necessary to have a worm, or other cooling apparatus, to condense the water from the gases before they are carried to the furnace, or they will, perhaps, extinguish the fire. While the distillation is going on the acid in the saturating vessel is frequently examined, and when it is thoroughly neutralized it is run out into a proper receiver, and is then transferred to shallow pans or troughs, where it is evaporated to the crystallizing point.

The residual liquor from the stills is not completely exhausted of ammonia, but contains from three to five ounces of sulphocyanide of ammonium per gallon. It is, therefore, treated with lime, and again distilled, whereby more ammonia is obtained.

If there were a large demand for the sulphocyanide, it might perhaps be worth while to recover it from the spent liquor, by evaporation, especially where it could be done by waste heat. Here is some of the residual liquor, and you will notice that when I add to it a very acid solution of a persalt of iron it produces a deep blood-red color of the *ferric-sulphocyanide.* Here also is some of the salt obtained from the

liquor by evaporation, and it is well suited for the preparation of this white powder, the mercuric sulphocyanide, which is the sole constituent of the little toys called Pharaoh's serpents. Sulphocyanide of ammonium is also used to some extent by photographers. I may here mention that the watery solution which runs from the hydraulic mains with the tar, when the temperature is not below 150° F., contains this salt, without any carbonate or sulphide of ammonium; there is no reason, therefore, why this solution may not be collected, apart from the true ammoniacal liquor which is found in the condensers, for even if it be not of much value on its own account, it might be kept from diluting the liquor in the first stages of condensation, and be afterward used instead of water for finally washing the raw gas.

In country gas works, where there is little or no sale for ammoniacal liquor, it would not be difficult to convert it into sulphate of ammonia, by transferring it to an old boiler, then blowing steam into it, and carrying the vapors into a properly constructed vessel, charged with the brown sulphuric acid of commerce, diluted with the mother liquor of a previous crystallization. In this way every ton of coals should yield about thirty pounds of sulphate of ammonia.

This sulphate is worth from £12 to £14 per ton, and it is not merely used for agricultural purposes, but it is the salt from which all other preparations of ammonia are obtained. Distilled with quicklime it yields pure ammonia, which by condensation in water forms the liquor ammoniæ of commerce; distilled with chalk it makes carbonate of ammonia; and it has other applications. There are good reasons, therefore, why great pains should be taken to recover all the ammonia of gas-making. We shall presently see how this may be further accomplished by means of absorbent agents placed at the end of the purifiers.

III.—COAL TAR.

This is a very complex liquid, for it contains at least three classes of compounds, viz: acids, neutral bodies, and alkaloids, the composition and leading properties of which are as follows:

Acids of coal tar.

Names.	Formulæ.	Specific gravities.	Boiling points, (F.)
Acetic	$C_4 H_4 O_4$	1062	243
Butyric	$C_8 H_8 O_4$	973	314
Carbolic	$C_{12} H_6 O_2$	1065	370
Cresylic	$C_{14} H\ O_2$	....	397
Phlorylic	$C_{16} H_{10} O_2$	....	424
Rosolic	$C_{24} H_{12} O_6$	....	....
Brunolic	?	....	....

Neutral bodies of coal tar.

Names.	Formulæ.	Specific gravities.	Boiling points. (F.)
Alliatous oils	?	?	?
Benzole	$C_{12}H_6$	850	177
Toluole	$C_{14}H_8$	870	230
Xylole	$C_{16}H_{10}$	867	264
Cumole	$C_{18}H_{12}$	870	299
Cymole	$C_{20}H_{14}$	861	341
Naphthaline	$C_{20}H_8$	1153	428
Anthracine	$C_{28}H_{10}$	1147	572
Pyrene	$C_{30}H_{12}$	....	?
Chrysene	$C_{24}H_8$	....	?

Basic or alkaline bodies of coal tar.

Pyridine	$C_{10}H_5N$	986	242
Pyrrol	C_8H_5N	1077	272
Picoline	$C_{12}H_7N$	961	271
Lutidine	$C_{14}H_9N$	946	310
Collidine	$C_{16}H_{11}N$	937	354
Parvoline	$C_{18}H_{13}N$	....	370
Aniline	$C_{12}H_7N$	1020	360
Toluidine	$C_{14}H_9N$	....	388
Xylidine	$C_{16}H_{11}N$	....	418
Cumidine	$C_{18}H_{13}N$	952	437
Cymidine	$C_{20}H_{15}N$	....	482
Chinoline	$C_{18}H_7N$	1081	462
Lepidine	$C_{20}H_9N$	1072	510
Cryptidine	$C_{22}H_{11}N$	....	525

The general properties of coal tar, as well as the proportions of its several constituents, vary with the quality of the coal used, and with the temperature at which it is distilled or carbonized. The tar which is produced from common gas coals at rather high temperature is always heavier than water, (sp. gr. 1.120 to 1.150.) It dries freely in the air, and its hydrocarbons are so rich in carbon that the tar cannot be burnt in an ordinary lamp. But the tar which is produced from cannel coal at lower temperatures is lighter than water, and does not readily dry when it is exposed to the air. Besides which, its hydrocarbons are comparatively poor in carbon, and may be burnt in lamps. There is almost every variety of coal tar from these two extremes, but the tars of commerce are chiefly of three kinds, viz: the rich cannel coal tar of Scotland, the tar which is produced from common coal in country gas works, where

the temperatures are generally low, and the still heavier tar of the London gas works, which is produced at excessively high temperatures. The yield of tar, per ton of coals, is from nine to fifteen gallons, the latter being the average at country works; and the former, or from that to ten gallons, is the yield in London, where the tar is undoubtedly affected by the high temperature of the retorts; for it is not only small in quantity, but it is deficient of naphtha, and contains more pitch than country tar, besides which the dead oil from it is always overloaded with naphthaline.

In London the distillation of coal tar is always effected in stills, which are placed over a fire, and the products are collected at different stages of the distillation. Up to a temperature of from 160° to 190° F. little or nothing flows over; but at that temperature ammoniacal liquor, with crude naphtha of a gravity of .850, begins to distil. These continue to flow until the thermometer rises to from 310° to 340°, when a heavier naphtha, of a gravity of about .920, is carried over. This is called light oil, and it is collected separately until the temperature rises to from 370° to 400°, and then the oil begins to have the gravity of water; after that, and up to the temperature of from 690° to 700°, the oil which is collected is heavier than water, and is therefore called heavy or dead oil, the last runnings having a gravity of 1.060 or thereabouts. If a soft pitch is wanted, the process of distillation is stopped at this stage; but if a harder pitch is required it is pushed a little further, and the green oil which flows over is rich in neutral oils, which are well suited for making railway grease.

A still containing 2,500 gallons of coal tar will in this way yield about the following proportions of the several products:

Ammoniacal liquor, from 50 to 70 gallons; average, 60 gallons.

Crude naphtha, from 30 to 50 gallons; average, 40 gallons.

Light oil, 12 to 35 gallons; average, 30 gallons.

Creosote or dead oil, 689 to 740 gallons; average, 720 gallons.

Pitch, 8 to 10 tons; average, 9 tons.

Each of these products has its commercial value, the naphtha and light oil being used for the production of benzole and toluole of commerce—naphthas which are largely in demand for the manufacture of coal-tar colors.

Formerly the greatest value was attached to the naphtha or benzole which had a low boiling-point, and the contracts, especially with the French, were for a benzole or naphtha which yielded ninety per cent. of volatile oil at a temperature not exceeding 212°, and I have examined thousands of gallons of this quality for the French market. Even at the present time there is a demand for this, which is called ninety per cent. benzole, for making certain aniline reds; and to obtain it the crude naphtha, or the first runnings from the tars, were distilled alone. At present, however, there being a demand for a less volatile oil, the practice is to mix together the crude naphtha and the light oil, and to subject them to fractional distillation, thus: steam is blown into them at a pressure of from twenty to thirty pounds on the inch, and the naphtha which

comes over with the steam is called "once-run naphtha." This is purified by shaking it with strong sulphuric acid, (sp. gr. 1.845,) using the acid in small proportions at a time, for fear of injuring the naphtha, and washing with water between each operation. In this manner, after using about five per cent. of acid, (or one-half pound to each gallon of naphtha,) the brown coloring matter of the naphtha and all basic compounds are either destroyed or removed, and the brown naphtha, after being well washed with water, is again distilled by blowing high pressure steam into it, and the products are collected at three stages; that which comes over first is called crude benzole of eighty per cent. strength, the second runnings are a naphtha containing fifty per cent. of benzole, and the third is a naphtha which is used for solvent purposes. With a view of strengthening the fifty per cent. benzole, and making it eighty per cent., it is redistilled from a vessel with a steam jacket, whereby the temperature can be regulated. That which flows over at a temperture up to 210° is set aside as eighty per cent. benzole; that which distils between 210° and 260° is called thirty per cent. naphtha; and the residuum, on being treated with high-pressure steam yields solvent naphtha. Once more, the thirty per cent. naphtha, or that which has flowed over at from 210° to 260°, is distilled with a dry steam heat, and when the thermometer has risen to 106° there is obtained a little more eighty per cent. benzole; after which, and up to 234°, there flows over what is called forty per cent. naphtha, and from 234° to 260° a little of the thirty per cent. Steam is then blown into it, and it yields a little of the solvent naphtha.

In this way, by a series of fractional distillations, the washed naphtha is made to yield at each successive operation a quantity of eighty and forty per cent. naphtha. All the eighty per cents. are then mixed together, and are once more distilled by a dry steam heat. The naphtha which flows over at a temperature up to 204° is called ninety per cent. benzole; that which flows between 204° and 210° is called eighty per cent. benzole, and is again fractionally distilled up to 204°; while the residue, on being treated with high-pressure steam, yields a quantity of forty per cent. naphtha.

Five separate products are thus obtained, namely, ninety per cent. benzole, forty per cent. benzole, solvent naphtha, the last runnings of the first operation, and the residuum of each distillation. Operating in this manner with a charge of 1,587 gallons of crude naphtha and light oil, there is first obtained 897 gallons of once-run naphtha and 56 gallons of the last runnings, the remainder (634 gallons) being a residuum of no value except for mixture with dead oil; and the 897 gallons of once-run naphtha yields, after it has been purified with sulphuric acid, 301 gallons of ninety per cent. benzole, 195 gallons of forty per cent., 237 gallons of solvent naphtha, 12 gallons of last runnings, and 152 gallons of residuum.

The forty per cent. benzole contains also fifty per cent. of volatile oil, chiefly toluole, which distils over between 212° and 248°. This is the oil which is preferred at the present time for the manufacture of coal-tar colors. The several products which are thus obtained in the distillation

of coal-tar are upon the table before you, and, roughly speaking, the proportions per 10,000 gallons of crude tar and their commercial values are as follows:

Forty per cent. benzole, 34.4 gallons, worth 2*s.* 4*d.* per gallon.

Ninety per cent. benzole, 53.1 gallons, worth 2*s.* per gallon.

Solvent naphtha, 41.8 gallons, worth 1*s.* 9*d.* to 2*s.* per gallon.

Last runnings, 12 gallons, worth 9*d.* per gallon.

Dead oil, 3,018.7 gallons, worth 1*d.* per gallon.

Pitch, 36 tons, worth 45*s.* per ton.

Before rectification the crude naphtha is worth about 1*s.* per gallon, and the light oil about 6*d.*, the two together fetching 9*d.* or 10*d.* a gallon; and once-run naphtha is worth 1*s.* 6*d.* a gallon. Two samples of this oil from different distillers yielded by fractional distillation the following percentage of proportions of oil at different temperatures:

Yield of oil by fractional distillation.

	Sample 1.	Sample 2.
Up to 212° Fahrenheit	15.0	17.5
From 212° to 248°	44.0	42.0
From 248° to 264°	8.0	8.5
From 264° to 300°	13.0	13.0
From 300° to 320°	5.5	4.5
Residuum	14.5	14.5
	100.0	100.0

The samples, therefore, in commerce from good markets may be regarded as of pretty uniform quality.

In Scotland the method of distilling coal tar is a little different from what it is in England, and this arises from the circumstance that the Scotch cannels yield a tar which is so rich in the volatile naphthas that it is not altogether safe to distil the tar from a still with a naked fire. The tar, therefore, is first submitted to the action of high-pressure steam, which is blown into it until the more volatile products are passed off. In this way from seven to thirteen per cent. of crude or rough naphtha is obtained with a gravity of about .930. The residuum is called boiled tar, and is distilled with a naked fire. It thus yields from six to seven and a half per cent. of a light oil called pitch oil or torch oil, which has a specific gravity of from .973 to .976. The next runnings, which amount to from twenty-seven to thirty per cent. of the boiled tar, are generally heavier than water, and are called heavy pitch oil, and they constitute the great bulk of the product.

The several products of coal tar are thus used in the arts:

COAL TAR is itself employed as a rough varnish for iron, and in Scotland the boiled tar is extensively used for covering woodwork, &c.

LIGHT OIL AND CRUDE NAPHTHA are either redistilled for procuring benzole and toluole, as I have already explained, or they are employed for making common black varnish, or for burning in naphtha lamps. In

this country they are for the most part distilled, but in Scotland they are largely used in a lamp called the foundery lamp. It is an enlarged form of a lamp which was patented many years ago by Mr. Beale, and it consists of a chamber supplied with naphtha, and having a nozzle or jet for directing a blast of air through it. The chamber is covered with a bell with a large hole in the top of it. When the naphtha is lighted and the bell put upon it, the blast of air forces the vapor of the burning naphtha through the hole in the top of the bell, and thus produces an enormously large volume of flame. The light is equal to at least a dozen gas jets, and the cost of it is said to be a penny a night. It is very generally used in the founderies, the ship-yards, and other large workshops of Scotland.

SOLVENT NAPHTHA is a colorless spirit, which is chiefly employed for dissolving India-rubber for waterproofing, and resins or pitch for varnishes.

The last runnings are also used for varnishes, for making a superior lampblack called spirit black, and for burning in Holliday's lamp, which is the common naphtha lamp of the streets. It is an ingenious contrivance for converting the naphtha into vapor by means of a mass of heated metal and spreading it out in a star-like form.

I have already alluded to the use of coal naphtha as a means of increasing the illuminating power of common twelve or fourteen candle gas, and have shown that with a moderately good naphtha, which yields about seven grains of vapor to every cubic foot of gas, the illuminating power may be increased about sixty per cent. Considering that naphtha is now becoming a drug in the market, from the waning of fashion in respect of coal-tar colors, it may be worth while to encourage its use as a naphthalizer, rather than to yield to the public clamor for cannel gas. I have long thought that gas, as well as water, should be dealt with at the consumers' houses, when in either case it is required to be of unusual quality.

THE CREOSOTE, OR DEAD OIL OF COAL TAR, is used almost entirely for the preservation of timber, and at the present moment, in the stagnant condition of railway business, it is almost unsalable. I apprehend, however, that it is valuable as a fuel, and that it will ere long be used in steam furnaces. Already there are several patents for its application in this manner, and experiments are now being conducted at Woolwich with the view of ascertaining its practical and economical capabilities. The contrivances which appear to offer the largest prospects of success are those which deliver the oil into the furnace in the form of a spray or vapor, by means of a jet of steam or blast of hot air; and it is said that the heating power of the oil is from two and a half to three times that of a similar weight of coal.

In applying the oil to the preservation of timber, it is necessary that it should be forced deeply into the tissue of the wood. The method employed by the best operators is to place the timber in large wrought-iron cylinders, and then to exhaust it of air and moisture as completely as possible by creating a vacuum. After a time the dead oil, heated

to a temperature of 120° F., and thus made as fluid as possible, is let into the cylinder. Pressure is then put upon it until the oil is forced into the wood with a power of 150 pounds upon the inch. In about three hours the wood absorbs the prescribed amount of creosote, which, with the best houses, is never less than from thirty pounds to fifty pounds of creosote to a load of fifty cubic feet of timber; every cubic foot of timber has, therefore, taken up from six pounds to ten pounds of oil.

The preservative power of the dead oil is partly due to the antiseptic properties of the creosote and partly to its filling up the pores of the wood with an oil which gradually resinifies and excludes air and moisture. Different views are entertained of the quality of creosote which is best suited for this purpose. In the contracts which I have prepared for the Indian railway works I have prescribed that the creosote should have the following properties: "It should have a density between 1.045 and 1.055; it should not deposit any crystalline matter at a temperature of 40° F.; it should yield not less than five per cent. of crude carbolic acid to a solution of caustic potash of the density of 1.070 (14° Twaddle;) and it should furnish ninety per cent. of liquid oil when distilled to the temperature of 600° F." The contracts, which I have lately seen, for the Dutch government prescribe that the creosote shall be clear and shall not deposit more than forty per cent. of naphthaline when cooled to the temperature of 32° and kept at that temperature for twenty-four hours. Here are specimens of creosote from country tar which fully realize those properties; but this sample from London tar is almost solid at 32°.

Another use to which dead oil has lately been put is the preparation of a dip for washing sheep. It was patented by Mr. M'Dougal in 1860, and is made by heating together two parts by weight of dead oil with one of a solution of caustic soda of 50° Twaddle, (sp. gr. 1.250,) which contains about fifteen per cent. of soda; and to this is added one part of tallow, fat, or other saponifiable substance. The mixture which is thus obtained has the appearance of a very dark soft soap, and it is either smeared upon the skin of the animal or dissolved in water and used as a wash.

The GREASY MATTER, OR GREEN OIL, which follows the dead oil in the distillation of coal tar, is used for making railway grease, with resin, oil, &c.; and the pitch which is the residual product of the distillation is largely employed for all sorts of purposes.

Looking, therefore, at the compositions of the principal products of coal tar distillation, it may be said that the crude naphtha contains certain alliaceous oils, with benzole, toluole, xylole, cumole, and a little cymole, besides the more volatile basic compounds, as pyridine, picoline, lutidine, collidine, and a little aniline, with from two to three per cent. of carbolic acid and a little naphthaline.

LIGHT OIL contains cumole, symole, and the other less volatile hydrocarbons, with a large amout of naphthaline, and the denser alkaloids, as collidine, aniline, toluidine, and even a little chinoline; besides which it contains from ten to twenty per cent. of carbolic and cresylic acids.

Heavy oil consists chiefly of hydrocarbons which have not been well studied, and the bases which have a high boiling point, as chinoline, lepidine, and cryptidine, with small quantities of cumidine and cymidine, and from seven to ten per cent. of carbolic and cresylic acids.

Carbolic acid ($C_{12}H_6O_2$), or, as it is sometimes called, phenic acid, is largely in demand for making dyes and for disinfecting purposes, and it is most profitably extracted from the light oil before it is distilled for benzole, &c. The naphtha which flows over between 300° and 400° F., and which has gravity below 900, is best suited for the preparation of carbolic acid; for although there is much acid in the heavier oils, yet they are so nearly of the same gravity as the alkaline solution used in extracting it that there is great difficulty in separating them. The light oil is well shaken with about one-third of its bulk of a solution of caustic soda of from 14° to 16° Twaddle (1.07 to 1.08 sp. gr.) and containing from five to seven per cent. of alkali. After standing for some time the oil separates, and the alkaline liquor may be drawn off by means of a syphon This is to be neutralized with sulphuric or muriatic acid, and then the carbolic acid floats as a dark brown oil. This is the crude acid of commerce, and when purified by means of sulphuric acid and careful distillation from chloride of calcium, it forms the camphor-like substance which you here see. It has a peculiar creosote-like smell, and when largely diluted with water, even to the extent of 1 part in 10,000, it has a sweet taste. It is a very powerful caustic, turning the skin white and quickly raising a painless blister. The specific gravity of the pure acid is 1.065. It melts at from 95° to 98° F., but the merest trace of water will lower its melting or congealing point, so that this is the test of the quality of the acid. It boils at 369° or 370° F., and its vapor burns with a sooty flame. If it be passed through a red-hot tube it is decomposed, forming napthaline and other hydrocarbons; and if it be heated for some time with ammonia in a closed tube, at a temperature of from 400° to 500° F., it produces aniline and water thus:

$$\underbrace{C_{12}H_6O_2}_{\text{Carbolic acid.}}+NH_3=\underbrace{C_{12}H_7N}_{\text{Aniline}}+{}_2HO$$

It combines with alkalies to form salts, but the combination is very feeble, for the acid is set free by heat and even by the carbonic acid of the atmosphere, so that the common preparation of it, carbonate of lime, slowly evolves carbolic acid when it is exposed to the air.

The acid is a very powerful antiseptic and disinfectant. It is especially destructive of the lower forms of organic life, and hence, perhaps, its value as a disinfectant. Several varieties of the acid are now prepared and sold for general and medical purposes, and the experience of the last few years has proved it to be an important hygienic agent. Its use in the preparation of dyes will be explained directly.

The other acids of coal tar, as *cresylic*, ($C_{14}H_8O_2$,) *phlorylic*, ($C_{16}H_{10}O_2$,) *rosolic*, ($C_{24}H_{12}O_6$,) may be obtained by the use of a stronger alkaline solution as recommended by Laurent. A saturated solution of potash,

added to the mixed light oil and heavy naphtha, and then treated with a little powdered caustic potash, will produce a magma from which the unattacked liquid oil may be separated. By dissolving it in a small quantity of water and allowing it to stand, it separates into two layers—an upper, oily layer, which is of no use, and a lower layer which contains the tar acids. When this is neutralized with muriatic acid, the crude acids float as an oily layer, and may be separated from each other by fractional distillation.

IV.—SPENT OXIDE OF IRON.

This is the next substance in order of the purification of coal gas. In its fresh state the hydrated peroxide of iron freely absorbs the sulphuretted hydrogen of foul gas, forming the black sulphide of iron. On exposure to the air the iron again absorbs oxygen, and becomes revived, the sulphur which it had before taken in as sulphuretted hydrogen being set free among the particles of the oxide. In this manner, by a succession of foulings and revivifications, the oxide becomes so charged with sulphur as to be unfit for use. It then contains from thirty-five to fifty-seven per cent. of sulphur, the average being about forty-two per cent.; and although it is useless at the gas works, it is of some value in the production of oil of vitriol. Special furnaces, however, are necessary for its combustion, for as it contains about twenty per cent. of sawdust it is not capable of being used in ordinary sulphur furnaces. At Messrs. Lawes and Messrs. Hills, where I have seen the spent oxide largely used for making sulphuric acid, the furnaces are constructed with very long flues, for the purpose of completely burning the organic vapor before it enters the vitriol chamber. Each furnace is about twelve feet long and eighteen inches square, with a floor of fire-brick, upon which the oxide burns. It takes about two and one-half cwt. of oxide at a charge, and it burns continuously for twelve hours. The air is admitted by a sliding door in front, and the gaseous products are conveyed from the furnaces, which are placed side by side, and in three tiers over each other, to a common flue at the back, and this is extended backwards and forwards, below and above, so as to prolong the combustion to the greatest extent before the vapors enter the vitriol chamber, for if the combustion is not complete there is a considerable waste of nitre; as it is, indeed, the quantity of nitre used for the oxidation of the sulphurous acid is always about half as much more as is required with native sulphur or pyrites. I think the process might be very considerably improved by continuous instead of intermittent burning, and there is no reason why the use of sawdust may not be abandoned altogether, and spent oxide employed in its place.

V.—SPENT OR REFUSE LIME.

This is generally a very profitless material—in fact, the blue billy from the wet-lime purifiers is incapable of any sort of application but that of

luting. Dry lime, however, is not so unmanagable a product, for if it is treated properly it need not occasion offense; and when it is well weathered it is of some value to the farmer. Professor Voelcker has inquired very fully into this matter, and he states that it is useful to certain soils on the following account:

1. It improves the texture of stiff clay soils by lightening them, and of light sandy soils by giving them solidity.

2. It neutralizes the acidity of some soils, and breaks up the organic matter of soils which are too rich in humus, making them more fit for the sustenance of plants.

3. It acts on the granitic constituents of a soil, and sets free the alkalies, thereby making the mineral elements of it available as food for the plant.

4. It supplies food to the plant in the form of sulphate of lime, which is especially useful to the leguminosæ.

And he concludes that well-weathered gas lime, judiciously applied to a proper soil, is most useful to many plants, as clover, sainfoin, lucerne, peas, beans, vetches, and turnips; and that it is a good fertilizer, for permanent pasture, especially if the land is deficient of lime. On natural grasses the best farmyard manure often produces but little improvement until a dressing of lime, marl, or gas lime has been applied to it; the latter, more particularly, destroys the coarser grasses, and favors the growth of a sweeter and more nutritious herbage. It also destroys moss, heath, feather-grass, and other plants which are characteristic of peaty land. It is, therefore, especially suited for the improvement of such land; and so it is for the land which is deficient of lime, and which causes turnips to become warty, and be affected with the disease called "fingers and toes." For this it has been found a complete remedy. It may be applied in quantities of from one to two tons an acre, and even more where lands are very heavy, or are very peaty; and the best time to apply it is in the autumn, when vegetation is dormant, so that it can not only weather before the spring returns, but also act on the land during the whole of the winter.

One special precaution is that the lime should never be used in its fresh state, when it contains sulphide and sulphite of calcium in such proportions as to be injurious to plants. The more it is oxidized the better, and, therefore, when it is drawn from the purifiers it should be covered with old material, so as to prevent smell, and kept until it has lost its activity. The fresh lime contains from fifteen to twenty-five per cent. of quicklime, with a large proportion of sulphide, carbonate, and sulphocyanide of calcium; and even after six or eight months it may still contain a notable proportion of quicklime, with from twenty to thirty per cent. of sulphate of lime, a like proportion of sulphite of calcium, and still more of carbonate, in which condition it is not injurious to plants.

In many places farmers are glad to have the material, and will give as much as 2*s.* a load for it, although the common price is about 1*s.* a load.

VI.—ACID AND OTHER ABSORBENTS OF AMMONIA.

At the end of all the purifiers there may be placed the material which has been patented by Messrs. Sugden and Maryatt. It is made by moistening sawdust with sulphuric acid slightly diluted with water, and heating it in a retort. The woody matter is in this way charred by the acid and contains from thirty to forty-five per cent. of free sulphuric acid. When it is exhausted by being charged with ammonia, it contains forty to sixty per cent. of salt, which is easily washed out of it, leaving the charred sawdust ready for another charge of acid. The material, with the sulphate of ammonia in it, is fit for conversion into manure, and is worth £5 or £6 per ton. Another absorbent of a like nature is that used by Mr. Croll. It is made from the spent chloride of manganese from the bleaching works by adding it to chalk and sawdust, and, when saturated with ammonia, it contains from thirty-nine to forty per cent. of muriate of ammonia, which is easily obtained from it either by washing or subliming.

These are several waste products of the manufacture of gas, and it will be seen that in the aggregate their value is not inconsiderable, provided they are utilized to the fullest extent.

COAL-TAR COLORS.

I will now make a few remarks on the processes which are followed for the production of coal-tar colors. Most of them are derived from the naphtha which is sold as forty per cent. benzole, which is a mixture of benzole and toluole with a little xylole. The first step of the process is to convert the constituents of this naphtha into the corresponding nitro-compounds, by carefully mixing it with fuming nitric acid or with a mixture of two parts of common nitric acid and one sulphuric. The reaction is very violent if the temperature is not controlled; but, with proper management, the three hydrocarbons lose each an equivalent of hydrogen to a like proportion of oxygen in the nitric acid, and gain the residual peroxide of nitrogen. Thus:

$$\underbrace{C_{12}H_6}_{\text{Benzole.}}+HNO_6=\underbrace{C_{12}H_5NO_4}_{\text{Nitrobenzole.}}+2HO$$

$$\underbrace{C_{14}H_8}_{\text{Toluole.}}+HNO_6=\underbrace{C_{12}H_7NO_4}_{\text{Nitrotoluole.}}+2HO$$

$$\underbrace{C_{16}H_{10}}_{\text{Xylole.}}+HNO_6=\underbrace{C_{16}H_9NO_4}_{\text{Nitroxylole.}}+2HO$$

These three nitro-compounds constitute the dark amber-colored, oily liquid which floats upon the acid; and when it is separated from the acid and washed with water, and then with a weak solution of carbonate of soda, it constitutes the crude nitrobenzole which is used for the manufacture of aniline colors.

It has a strong odor of bitter almonds, is heavier than water, and is very soluble in alcohol and ether. If this crude nitrobenzole be submitted to the action of a reducing agent, each of the nitro-compounds will lose its four equivalents of oxygen, and gain two of hydrogen, and be thereby converted into a corresponding alkaloid, thus:

$$\underbrace{C_{12}H_5NO_4}_{\text{Nitrobenzole.}}+6H=\underbrace{C_{12}H_7N}_{\text{Aniline.}}+4HO$$

$$\underbrace{C_{14}H_7NO_4}_{\text{Nitrotoluole,}}+6H=\underbrace{C_{14}H_9N}_{\text{Toluidine.}}+4HO$$

$$\underbrace{C_{16}H_9NO_4}_{\text{Nitroxylole.}}+6H=\underbrace{C_{16}H_{11}N}_{\text{Xylidine.}}+4HO$$

This process of reduction may be effected by sulphide of ammonium, (Zinin's method,) or by the nascent hydrogen evolved when zinc is treated with dilute sulphuric acid, (Hofmann's method,) or by acting on the nitro-compounds with iron and acetic acid, (Bechamps's process.) I show you here an experimental illustration of each of these processes, and you will observe that for lecture experiment the process of Hofmann is the most striking, but in practice the method of Bechamps is the most economical.

One hundred parts of the crude nitrobenzole is mixed with nearly its own weight of strong acetic acid, and to this is added little by little about 150 parts of iron turnings. The mixture is generally made in an iron retort, and after being well stirred it becomes hot, and soon forms a pasty mass of oxide of iron with an acetate of aniline and the other bases. The reactions are somewhat intricate, but they may be practically expressed thus—

$$\underbrace{C_{12}H_4NO_4}_{\text{Nitrobenzole.}}+4Fe+2HO=\underbrace{C_{12}H_7N}_{\text{Aniline.}}+2(Fe_2O_3)$$

And the same for the other nitro-compounds, so that theoretically the acetic acid should act indefinitely.

The mixture is then submitted to heat until the retort is nearly red hot, by which means impure aniline, &c., distils over, and when this is treated with a slight excess of lime or soda, and again distilled, it yields the crude aniline of commerce. The best product is obtained when the distillation is going on between the temperatures of 340° and 380°, for as the temperature rises to 626° two new alkaloids are produced, which Hofmann has named paraniline ($C_{24}H_{14}N_2$) and xenylamine ($C_{24}H_{11}N$.)

Other processes have been suggested for the production of aniline and its homologues from the nitro-compounds; thus Kremer has recommended the use of finely powdered zinc; Wöhler, an alkaline solution of arsenious acid; Wagner, the ammoniacal solution of suboxide of copper; and Vohl, an alkaline solution of grape sugar; but none of these methods have taken the place of Bechamps.

The crude aniline of commerce, which is a mixture of aniline and toluidine, is more or less deeply colored liquid of an amber tint; it is heavier than water, and it acquires a blue or red color by various oxidizing agents. A solution of chloride of lime turns it, as we see, of a bluish-purple color. It was this reaction which suggested the name of kyanol—blue oil. Acidulated with a mixture of equal parts of water and strong sulphuric acid, and treated with peroxide of manganese or peroxide of lead, it produces, as you observe, a rich blue. Chromic acid makes it, as you may see, of a green, a blue, or a black color, according to the degree of oxidation; but the most remarkable experiment of all is the coloration of the aniline when it is acidulated with dilute sulphuric acid and submitted to the action of the galvanic battery. At the platinum pole, where oxygen is evolved, it instantly becomes bronze-green, then blue, then violet, and finally red; showing that the coloration of the alkaloid is due to the nascent oxygen, and that the tint corresponds to the degree of oxidation.

The crude aniline dissolves to some extent in water, but it is more freely soluble in alcohol and ether. It readily combines with acids, and forms crystalline compounds; hence it was called crystalline by Unverdorben, its discoverer. These salts become colored on exposure to the air.

The production of colors from this liquid was the remarkable feature of the Exhibition of 1862. It dates from the year 1856, when Mr. Perkin discovered and patented the process for making a rich violet from aniline by means of bichromate of potash; but it is right to say that several chemists had long before noticed the fact that the salts of aniline were capable of producing rich colors. Runge, in 1835, obtained a violet blue by acting on one of the oily constituents of coal tar with chloride of lime. Five years afterwards Fritzsche observed the blue coloration of aniline with chromic acid, and the like thing was described by Beisenhirtz; but none of these reactions commanded attention until the year 1859, when Messrs. Guinon, Marnas, and Bonnet, of Lyons, introduced a new fast purple under the name of French purple, which they obtained from orchil, and which became a favorite and fashionable color. The mauve of Mr. Perkin, which had been for three years before the public, was so much like it, that it rose suddenly into public favor. The year after, in 1859, M. Verguin, of the firm of Rénaud Brothers, of Lyons, obtained a brilliant red from the same base, and it was patented by them under the name of fuchsine. These two results commanded so much attention that the scientific and technical world entered very earnestly into the investigation with the view of discovering new processes of manufacture; and at the present time we have the means of making almost every variety of tint from coal-tar products. Most of these dyes are called aniline colors, but in truth they are produced from toluidine as well as aniline, and, as we shall see hereafter, they are obtained by processes of oxidation and substitution. They are generally classified under the heads of violets, reds, blues, greens, blacks, yellows, &c.

VIOLETS.

These have received a variety of fanciful names, as mauve, violine, rosolane, tyraline, indisine, harmaline, imperial violet, regina purple, &c., &c.

The first of them was obtained in 1856 by Mr. Perkin, whose patent is dated the 26th of August of that year. His process is to add equivalent proportions of diluted solutions of a salt of aniline (generally the sulphate) and bichromate of potash. A good proportion is two parts by weight of aniline, two of bichromate of potash, and one of sulphuric acid of English commerce. The aniline and sulphuric acid are first mixed and then dissolved in water. To this solution is added the bichromate of potash, also previously dissolved in water, and after being well stirred they are allowed to remain quiet for ten or twelve hours, when a dark-colored sediment appears. This is to be collected upon a filter and well washed with cold water. It is then dried and treated with colorless coal-tar naphtha until all brown, tarry, and resinous matter is dissolved away. After this it is again dried and boiled in successive portions of alcohol or methylated spirit until the whole of the violet coloring matter is dissolved out. The spirit solutions are then distilled in order that the spirit may be recovered, and the residue is mauve. It amounts to only about four or five per cent. in weight of the aniline used, but its tinctorial power is very great. In this condition it is not absolutely pure, although it is sufficiently so for common purposes. To purify it, it must be boiled in a large quantity of water, and the solution treated with an alkali. The coloring matter which precipitates is to be collected upon a filter, washed with water until all trace of alkali is removed, and then dissolved in spirit. If the spirituous solution be evaporated to dryness, the pure coloring matter remains as a beautiful bronze-like substance. It is hardly at all soluble in water, ether, or coal-tar naphtha; but it freely dissolves in spirit and in weak acids, especially acetic. Concentrated sulphuric acid dissolves it without decomposing it, and forms a dirty green solution, which becomes of a beautiful blue color with a little water, and a violet or purple with a good deal. It is, therefore, a very permanent body, although it will not resist the action of chlorine or nitric acid. Reducing agents, as sulphide of ammonium or protosulphate of iron, change it to a brown-colored solution, which reacquires its violet tint on exposure to the air. Like most of the aniline dyes it forms a very insoluble colored precipitate with tannin.

Other processes have been patented for making this color; thus, Bolley, in 1858, Beale and Kirkham, in 1859, and Depouilly and Lauth, in 1860, patented the use of chloride of lime with a salt of aniline. These solutions, when used in proper proportions, produce an insoluble purple precipitate, which is the mauve of Perkin. It is purified by washing it with water slightly acidulated with sulphuric acid, then dissolving it in concentrated sulphuric acid, reprecipitating with water, washing it with

water upon a filter, and lastly dissolving in spirit. In 1859 Mr. Kay patented a process for obtaining it by adding peroxide of manganese to a strong solution of sulphate of aniline, and keeping the mixture for some hours at the temperature of boiling water. The purple solution thus obtained is to be filtered and precipitated by adding ammonia until the acid is neutralized, and the precipitate, when collected upon a filter, washed with water, and then dissolved in spirit, forms the violet-colored dye called harmaline. In the same year Mr. D. Price produced a patent for manufacturing the color by means of peroxide of lead instead of peroxide of manganese, and Mr. Greville Williams obtained a patent for permanganate of potash. The year after (1860) there were several patents for it, as Mr. Stark's, with ferricyanide of potassium, and Messrs. Dale and Caro's, with perchloride of copper and chloride of sodium.

In the year 1861, Mr. Adam Girard observed that a purple color could be obtained from aniline red by mixing it with its own weight of aniline and exposing it for several hours to a temperature of 350° Fahrenheit, which is a little short of the boiling point of aniline. The mixtures employed were equal parts of dry muriate of rosaniline and aniline, and the product, which is a reduced condition of aniline red, is washed with water slightly acidulated with muriatic acid until all the unacted on aniline and aniline red are removed, and the pure purple remains. This is dissolved in spirit of acetic acid, and forms the dye called Imperial purple. In the year following, (1862,) Mr. Nicholson obtained his patent for procuring the same color by merely heating magenta or aniline red to a temperature of from 390° to 420° Fahrenheit. The substance first melts, and, after evolving ammonia, is changed into the purple which he named Regina purple.

ANILINE REDS,

called fuchsine, roseine, azaleine, rosaniline, Magenta, Solferino, and other fanciful names, are conspicuous in the American section of the Paris Exhibition of this year. This color was obtained by Dr. Hofmann as far back as the year 1843, when he was experimenting on aniline with fuming nitric acid; and fifteen years later, in 1858, he again obtained it, when he was studying the reactions of bichloride of carbon on aniline. He found, indeed, that when three parts of aniline were heated with one part of bichloride of carbon for some time a resinous mass was produced, which furnished to alcohol a rich crimson color. This was aniline red; but, as he was studying the reactions for other purposes than the formation of colored products, he merely noticed the fact, and put it upon record. A year after Messrs. Verguin and Rénaud Brothers, of Lyons, discovered and patented their process for making fuchsine, or aniline red, from aniline, by means of bichloride of tin; and thus a practical value was given to the scientific researches of Dr. Hofmann. Fuchsine is obtained by heating together ten parts of aniline and six of anhydrous bichloride of tin in a glazed iron vessel for fifteen to twenty minutes. The temperature

should be about that of the boiling point of the mixture, (302° F.) At first the mixture becomes yellow, then gradually more and more red, until the liquid mass looks black. When this occurs it is allowed to cool, and the mass is treated with a large quantity of boiling water, which acquires a rich crimson color. This is the dye, and it may be used at once, or purified by adding to it a quantity of common salt, in which solution the dye is insoluble. The precipitated coloring matter is allowed to subside, and, after being collected upon a filter, it is dissolved in spirit, or acetic acid, and so forms the red dye. The process patented by Mr. David Price in the year following, (1859,) was to act upon a solution of sulphate of aniline with peroxide of lead, by boiling them together in the proportion of one equivalent of the former to two of the latter, until the solution acquires a deep red color. This is filtered, and, after being concentrated by evaporation, it is again filtered to separate a resinous substance which forms in it. An alkali is then added to neutralize the acid, and the coloring matter is precipitated as a dirty brown powder. When this is collected upon a filter, washed with water, and dissolved in spirit or acetic acid, it forms a beautiful red dye, which is fit for use. Messrs. Simpson, Maule, and Nicholson used this process very largely until the beginning of the year 1860, when Dr. Medlock committed to them his patent for making aniline red by means of arsenic acid. The process now followed is to mix together a highly concentrated solution of arsenic acid with aniline, using the latter a little in excess. A good proportion is twenty parts, by weight, of sirupy arsenic acid, containing seventy-six per cent. of the solid acid, and twelve of commercial aniline. In this manner a pasty mass of arseniate of aniline is formed, and, when this is heated for some time at a temperature of about 300° Fahrenheit, it intumesces, and at last forms a dark-colored liquid, which, on cooling, sets into a resinous solid, with a bronze-like luster. The crude coloring matter thus obtained is very soluble in spirit or water, and may be at once used for dyeing purposes, but it is better to purify it by adding a slight excess of slaked lime to the aqueous solution, and so precipitating the coloring matter with the insoluble arsenical salts of lime. The mixed precipitates are collected upon a filter, and the coloring matter dissolved out with acetic or tartaric acid. Another and better method of purification is to dissolve the crude mass in dilute muriatic acid; then to filter, and to precipitate by adding a slight excess of alkali, (carbonate of soda.) The color thus set free is to be collected upon a filter, washed with water, and then dissolved in spirit and acetic acid.

Another variety of aniline red, the nitrate of rosaniline, or azaleine, has been extensively manufactured in England by the process of Mr. Perkin, and in France by that of M. Geber Keller. Mr. Perkin heats a mixture of aniline, or its homologues, with dry pernitrate of mercury for some time at a temperature of 347° F. The mixture first becomes brown, and then gradually acquires a dark crimson color, during which time the mercury is reduced, and settles to the bottom of the

fused mixture. On pouring it off and allowing it to cool, it forms a solid mass of impure nitrate of rosaniline, which may be purified by dissolving in water, and precipitating with common salt. M. Gerber Keller's process is nearly similar, except that he uses a lower temperature. He takes ten parts of aniline and seven or eight parts of dry pernitrate of mercury, and heats the mixture for several hours in a bath of boiling water. Messrs. Dale and Caro obtain the color by heating a mixture of equal parts of aniline and powdered nitrate of lead, and then adding, little by little, a fourth part of anhydrous phosphoric acid. Other processes have also been patented, as that of Lauth and Depoully, (1860,) with nitric acid; that of Smith, (1860,) with perchloride of antimony, antimonic acid, peroxide of bismuth, stannic, ferric, mercuric, and cupric oxides; and Gerber Keller has claimed almost every common metallic salt that is known. As might be expected, a number of these processes are practically useless, and have been claimed for no other purpose than that of anticipating the profits of future discoveries.

ANILINE BLUES,

called azeleine, Bleu de Paris, Bleu de Lyons, Bleu de Mulhouse, &c. Soon after the discovery of aniline red it was observed that certain reducing agents had the property, when heated with it, of changing its color to a purple or blue. Mr. Charles Lauth, for example, in 1860, described the blue color which was obtained from azaleine (nitrate of rosaniline) by means of protochloride of tin, aldehyde, the natural essences, &c.; and M. Kopp demonstrated that the same color was produced from aniline red by means of wood spirit. But as none of these colors were permanent, they were disregarded. In 1861 MM. Girard and De Laire procured their imperial purple in the manner already mentioned, by heating equal weights of aniline and dry muriate of rosaniline, at a temperature of about 350° F. for several hours. If the purple is wanted, the mass is merely treated with dilute muriatic acid until it loses its excess of aniline and aniline red; but if a pure blue is required, the acid treatment is continued until all the red tint is removed, and a pure blue remains. This is finally dissolved in acetic acid, or methylated spirit, and the blue dye, called Bleu de Lyons, is obtained. The same blue, but called Bleu de Paris, was procured by MM. Persoz, De Luynes, and Salvetat, by heating a mixture of aniline and dry bichloride of mercury in a sealed tube for thirty hours, at a temperature of 356° F. The mass when cold is dissolved in boiling water, and the color precipitated by means of common salt. This operation is repeated until the blue is quite free from the green pigment which accompanies it.

A blue, called Bleu de Mulhouse, may be obtained by the process patented by MM. Gros-Renaud and Schœffer in 1861, and which consists in boiling a solution of azaleine (nitrate of rosaniline) with gum lac and carbonate of soda for some time; and another blue, named azuline, has been produced by M. Marnas by a like treatment of a substance called

peonine, with eight times its weight of aniline; and the residuum is purified with a succession of solvents, as water acidulated with muriatic or sulphuric acid, then hot naphtha, then caustic alkali, and finally with water acidulated with muriatic acid. The azuline or blue color which remains is soluble in spirit, and forms a rich blue dye.

Blues are also produced by the action of numerous oxidizing agents on aniline or its salts, as by a solution of hypochlorous acid, (Hofmann,) by a solution of chlorate of potash and muriatic acid, (Fritzsche,) by peroxide of hydrogen, (Lauth,) by perchloride of iron or red prussiate of potash, (Kopp,) by peroxide of manganese or pernitrate of iron and hydrochloric acid, (Schenrer-Kestner,) by bichromate of potash and acid, (Willm,) and I have obtained it by oxidizing the sulphate of aniline by means of the oxygen disengaged at the positive pole of a battery. In all these cases the blue is very difficult of solution, for it resists the action of every solvent but strong sulphuric acid. Taking advantage of this, Mr. Nicholson, in 1862, patented a process for purifying the blue coloring matter, by dissolving it in concentrated sulphuric acid, and then heating it for half an hour at a temperature of 302° F. By diluting it with water it is precipitated in a modified condition, for it is now soluble in pure water. Dr. Hofmann ascertained that it was a substitution compound of rosaniline, in which three equivalents of hydrogen had been substituted by three equivalents of a hydrocarbon, called phenyl ($C_{12}H_5$.) He therefore named it tryphenylic-rosaniline; and this suggested the possibility of substituting other hydrocarbons, as methyl, (C_2H_3,) ethyl, (C_4H_5,) amyl, ($C_{10}H_{11}$,) &c., in which he was successful by acting upon rosaniline with the iodides of these radicals, and thus producing ethylic, methylic, and amylic substitution compounds of a rich blue and purple color, called Hofmann's blues. Very recently the change has been effected by a more direct process, without the aid of the iodide, but by heating a mixture of aniline, muriatic acid, and methylic alcohol under pressure, and then treating with iodine and chlorate of potash, or other oxidizing agent.

ANILINE GREENS.

Most of the blue substances just described become green by the action of acids, and again acquire a blue color when they are washed or treated with alkalies. It has also been noticed that in certain states of oxidation, aniline acquires a green tint; but all attempts to utilize this color failed until, in 1860, Messrs. Calvert, Clift, and Lowe patented the process for producing it upon the fabric. Their process was to prepare the fabric with chlorate of potash, and then to print upon it with acid muriate of aniline. In a few hours a beautiful bright green color, called emeraldine, gradually appeared, and it was fixed by merely washing it with water. If a blue tint were required, the fabric was passed through a solution of bichromate of potash, when the oxidation of the aniline

was carried still further, and a dark indigo-blue, called azurine, was produced.

A green color may also be obtained by heating a mixture of two parts fuchsine with three parts strong sulphuric acid and one part water. When the solution of the fuchsine is complete it is allowed to cool, and four parts of aldehyde are added. The mixture is again heated until it is a bright blue color without a trace of violet. It is then treated with a boiling solution of hyposulphite of soda, and filtered. The residue upon the filter is to be boiled in water, and filtered while hot. After standing twenty-four hours it deposits a green precipitate.

ANILINE BLACK.

Several processes have been proposed for making a black dye from aniline, as by acting on aniline with an oxide of chlorine, and then with a salt of copper; but the color is not of sufficient importance to command attention.

ANILINE YELLOW,

called chrysaniline or phosphine. This color was first obtained by Mr. Nicholson in 1861. He procured it from the residuum of rosaniline by the action of steam, whereby a dirty yellow solution was obtained. On adding nitric acid to the solution, the yellow dye was thrown down as a nitrate of little solubility, and by decomposing it with an alkali the base is set free, which, either alone or in a form of a soluble salt, communicates a rich yellow color to silk and wool.

These are the principal colors obtained from aniline, and it may be of interest to examine the leading properties of these remarkable compounds. At first you will have remarked that the bases of nearly all the aniline colors are very insoluble in water, ether, and coal naphtha. They are more soluble in water acidulated with the mineral acids, and are still more soluble in acetic acid. Alcohol, however, is the great solvent for them. You will likewise observe that they are generally precipitated from their saline solutions by alkalies and by common salt, and in this manner they are generally purified. Tannin also produces an insoluble compound with them, and thus they are often fixed upon vegetable fabrics. They are endowed with great power of resistance, for they will bear the action of strong sulphuric acid without undergoing decomposition, but they cannot resist the action of powerful oxidizing agents, as chlorine, chloride of lime, or nitric acid. Reducing agents, as sulphide of ammonium and protosulphate of iron, destroy their color; but the action is not permanent, for on exposure to the air oxygen is absorbed, and the color reappears.

The bases themselves are not generally colored, but they acquire their characteristic tints when they combine with acids. I have here the colorless, or nearly colorless, solutions of rosaniline, mauvine, and aniline blue, and you will remark that directly I expose them to the vapors of an acid (acetic) their characteristic tints appear.

The tinctorial power of these dyes is remarkably great. If, for example, I put a little Magenta, mauve, or aniline blue upon paper, and then shake off the powder as completely as possible, there yet remains sufficient to give deep tints when I blow a fine spray of alcohol and acetic acid upon the paper.

The affinity of animal substances, as silk, wool, feathers, horn, ivory, leather, &c., is so great that the dye instantly combines with them, and produces a permanent stain. The affinity, indeed, is so great that, as you will see here, a piece of flannel will completely absorb and remove the coloring matter from its solution in water. Vegetable tissues, however, have no such affinity for the color, and therefore processes must be adopted for fixing the dye upon cotton and linen fabrics. One of these processes is to prepare the fabric with some animal substance, as albumen, serum of blood, the caseine of milk, or the gluten of wheaten flour. Advantage is also taken of the power which tannin has of combining with the color and rendering it insoluble. The process of Messrs. Puller and Perkin is to soak the cotton tissue in a decoction of sumach, or other tannin material, for an hour or two, and then in a solution of stannate of soda for another hour; after which it is dipped into dilute sulphuric acid, and is then ready for the dye. By these contrivances the aniline colors are made fast upon all kinds of vegetable fabrics.

Starch appears to have the power of fixing the colors, for if shaken with weak solutions of them, it will absorb the color, and, by falling to the bottom of the liquid, leave the solution colorless.

THEORY OF THE FORMATION OF COLORS.

The rationale of the change which takes place during the formation of the several colors is not altogether clear, although there can be no doubt that the essential part of it is the oxidation of aniline; for, as I have already stated, when a salt of aniline is exposed to the action of nascent oxygen set free from the positive pole of a galvanic battery, the characteristic tints of aniline are successively and quickly produced. At first there is bright yellow, then green, blue, violet, and lastly red, as if these were the successive phases of oxidation. The researches of Dr. Hofmann have demonstrated that all the aniline reds are salts of a well-defined base, which he has named rosaniline; and the more recent inquiries of MM. de Laire, Girard, and Chapoteaut have shown that there are four such bases entering into the composition of coal-tar colors, as violaniline, mauvaniline, rosaniline, and chrysotoluidine, which form an arithmetical series advancing by successive additions of C_2H_2, thus:

Violaniline	$C_{36}H_{15}N_3$
Mauvaniline	$C_{38}H_{17}N_3$
Rosaniline	$C_{40}H_{19}N_3$
Chrysotoluidine	$C_{42}H_{21}N_3$

Each of these bodies is produced in the same manner, by the oxidation and removal of six atoms of hydrogen from three atoms of aniline, or three atoms of toluidine, or three atoms of the mixed bases, thus:

Six atoms of hydrogen from three atoms of aniline produce violaniline.

$$\underbrace{3(C_{12}H_7N)}_{\text{Aniline.}}-H_6=\underbrace{C_{36}H_{15}N_3}_{\text{Violaniline.}}$$

Six atoms of hydrogen from two atoms of aniline and one of toluidine produce mauvaniline.

$$\underbrace{2(C_{12}H_7N)}_{\text{Aniline.}}+\underbrace{2(C_{14}H_9N)}_{\text{Toluidine.}}-H_6=\underbrace{C_{38}H_{17}N_3}_{\text{Mauvaniline.}}$$

Six atoms of hydrogen from one atom of aniline and two of toluidine produce rosaniline.

$$\underbrace{C_{12}H_7N}_{\text{Aniline.}}+\underbrace{2(C_{14}H_9N)}_{\text{Toluidine.}}-H_6=\underbrace{C_{40}H_{19}N_3}_{\text{Rosaniline.}}$$

And six atoms of hydrogen from three atoms of toluidine produce chrysotoluidine.

$$\underbrace{3(C_{14}H_9N)}_{\text{Toluidine.}}-H_6=\underbrace{C_{42}H_{21}N_3}_{\text{Chrysotoluidine.}}$$

These color bases are perfectly homologous in all respects, for they not only unite with acids to form salts which crystallize very freely, and which have remarkable tinctorial power, but they also contain within them three atoms of typic hydrogen, which may be replaced by certain radicals, as of the alcohols, &c.—methyl, ethyl, phenyl, &c.—forming derivative compounds of like basic properties, and frequently of high tinctorial quality.

The best known of these bases is rosaniline, which in its anhydrous condition is represented by the formula

$$C_{40}H_{19}N_3,$$

but which always contains two atoms of water in the hydrated state in which it is set free from its compounds, thus:

$$C_{40}H_{19}N_3,2HO.$$

It is readily obtained by decomposing its salts—the aniline reds—with an excess of alkali, soda, or ammonia, and in this state it falls as a dirty yellow or brownish-yellow precipitate; but by careful purification it occurs as a colorless base, which quickly becomes rose-red on exposure to any acid, even the carbonic acid of the atmosphere. It is nearly insoluble in water, slightly so in ammonia, and very soluble in alcohol, forming a deep red solution. Ether and coal-tar naphtha have no solvent action upon it. It combines with one, two, or three equivalents of acid to form salts which crystallize very readily, the first of them, the mono-acid salts, being remarkable for their lustrous metallic or bronze-

like appearance and their beautiful rose-red solutions; these, indeed, are the true coloring compounds, the most important of which are the following:

Fuchsine, or muriate of rosaniline	$C_{40}H_{19}N_3,HCl$
Azaleine or Magenta, the nitrate	$C_{40}H_{19}N_3,HNO_6$
Roseine, the acetate	$C_{40}H_{19}N_3,HC_4H_3O_4$

It was the last-named salt which composed the splendid bronze-like crystals of the crowns which were exhibited in 1862 by Mr. Nicholson. And, besides these, there are sulphate, arseniate, oxalate, chromate, tannate, &c., of rosaniline. Most of them are freely soluble in water and in spirit, but the tannate is so insoluble in water that it is used for fixing the color upon calico, and for recovering the dye from very weak solutions. To this end the otherwise waste products of aniline red are treated with a fresh infusion of nut-galls, and in a short time the rosaniline is precipitated in the form of a magnificent red lake of tannate of rosaniline, leaving the solution quite colorless. This lake is soluble in spirit and in acetic acid, and may be thus used for dyeing.

The salts of rosaniline with two equivalents of acid have not been studied, and even those with three of acid are not of any technical value.

Under the influence of reducing agents, as sulphide of ammonium, or the nascent hydrogen evolved from zinc when a solution of rosaniline in muriatic acid is left in contact with the metal, it is rapidly decolorized, and is transformed into a new base, which Dr. Hofmann has named leucaniline. This is effected by the absorption of two atoms of hydrogen, thus:

$$\underbrace{C_{40}H_{19}N_3}_{\text{Rosaniline.}}+2H=\underbrace{C_{40}H_{21}N_3}_{\text{Leucaniline.}}$$

The new base occurs in the form of colorless acicular crystals, which are scarcely at all soluble in water, but freely so in alcohol. The salts of it are also colorless, or dazzling white, although they reacquire the red tint of rosaniline when their solutions are exposed to the action of oxidizing agents or even to the air.

Dr. Hofmann has ascertained that there is still another base derivable from, or closely related to, rosaniline—viz: chrysaniline. It is procured from the residual, or waste product of rosaniline, by the action of steam and nitric acid, as I have already described. It contains two atoms less of hydrogen than rosaniline, and therefore it stands in its relation to this base as rosaniline does to leucaniline, thus:

Chrysaniline	$C_{40}H_{17}N_3$
Rosaniline	$C_{40}H_{19}N_3$
Leucaniline	$C_{40}H_{21}N_3$

It is very soluble in water, and it forms yellow salts with acids, one of which, the nitrate, is a very soluble compound. The solutions of the

base and of its salts communicate a splendid golden yellow color to animal tissues.

Aniline blues are, for the most part, substitution compounds of aniline red, the three atoms of typic hydrogen being replaced by three of an organic radical. The blue, for example, which is produced by the action of aniline on a salt of rosaniline, is a compound in which the three atoms of hydrogen are replaced by three of phenyl, thus:

Aniline red, or rosaniline.................................$C_{40}H_{19}N_3$

Aniline blue, triphenylic rosaniline.................$C_{40}\left\{\begin{matrix} H_{16} \\ (C_{12}H_5)_3 \end{matrix}\right\}N_3$

And its production when aniline is heated with a salt of rosaniline is accompanied with the evolution of ammonia, disregarding the acid of the compound, thus:

$$C_{40}H_{19}N_3+3C_{12}H_7N=C_{40}\ldots\ldots\left\{\begin{matrix} H_{16} \\ (C_{12}H_5)_3 \end{matrix}\right\}N_3+3NH_3$$

Other substitution compounds, in which the three atoms of hydrogen are replaced by three of methyl, ethyl, amyl, &c., have been produced by Dr. Hofmann by the action of the iodides of these radicals on the salts of rosaniline, or even by the more simple and direct process of heating them with the alcohols of the radicals under pressure. All these compounds are basic in their character, and they mostly form, with one equivalent of an acid, the blue colors which are known as Hofmann's blue and violet, and the violet of Paris.

The other bases of aniline and toluidine colors have not been so well studied, but it is very probable that the reactions and the general properties of violaniline, mauvaniline, and chrysotoluidine, are very similar to the preceding, and that they are capable of forming the like reduction and substitution bases.

CARBOLIC ACID COLORS.

Four or five dyes have already been produced from this compound, namely, rosolic acid or aurine, peonine or coralline, azuline, and picric acid.

Rosolic acid is contained in coal-tar, as was first demonstrated by Runge in 1834, who extracted it from the dark red-brown residual product of carbolic acid by means of spirit; and on treating the solution with caustic lime, he separated a brown compound, (brunolate of lime,) and obtained a red solution, (rosolate of lime,) from which he precipitated the rosolic acid as a dark red powder by the aid of acetic acid. Other observers, as M. Tschelnitz in 1857, and Dr. Hugo Müller still later, noticed that the common carbolate of lime of commerce became red on exposure to the air, and that this was due to the formation of rosolate and brunolate of lime; but we are indebted to Dr. Angus Smith, and more recently to M. Jourdan, for an explanation of the changes which thus take place in carbolate of lime, and for suggestions for a process for making the dye on a commercial scale. They found that when the

vapor of carbolic acid is passed over a hot mixture of soda and peroxide of manganese, or peroxide of mercury, oxygen is absorbed and rosolic acid produced, thus:

$$\underbrace{2C_{12}H_6O_2}_{\text{Carbolic acid.}}+O_2=\underbrace{C_{24}H_{12}O_6}_{\text{Rosolic acid.}}$$

The residue yields to water a rich solution of rosolate of soda, from which the rosolic acid can be obtained by precipitating by means of acetic acid.

The production of acid commercially has been accomplished and patented by Messrs. Guinon, Marnas, and Bonnet. They mix together about 23 parts, by weight, of carbolic acid, 10 to 20 of oxalic acid, and from 7 to 14 of commercial sulphuric acid, and heat them for three hours or until the desired color is obtained. The product is well washed with water to remove the excess of acid, and the residue, which is impure rosolic acid (aurine,) is a soft pitchy material with a green shade of cantharides; but as the acid is insoluble in water and cannot well be fixed upon fabrics, the patentees have converted it into a new compound, named peonine, by incorporating nitrogen with it.

Peonine or coralline is produced by heating one part of the rosolic acid with two parts of ammonia of commerce, for three hours, in a closed metallic vessel at a temperature of 270° F. The product is a thick liquid of considerable tinctorial power, and which gives with acids a deep red insoluble or fast color, which may be so applied to silk, wool, and other textile fabrics.

Azuline, as I have already stated, is a blue color, produced by heating five parts of peonine with six or eight of aniline, and keeping them at nearly the boiling point for several hours.

Picric acid, or carbazotic acid, or trinitrophenic acid, is obtained by oxiding carbolic acid with nitric acid. It was formerly procured by a like treatment of indigo and the yellow resin (Xanthorrhea hastilis) of Australia, and also by the action of nitric acid upon the coal naphtha which distils between 300° and 400° F.

When carbolic acid is cautiously dropped into strong nitric acid it is attacked with great violence and with a hissing noise, as you may observe; and, according to the strength of the acid, there are produced one or more of the following substitution compounds:

Carbolic acid	$C_{12}H_6O_2$
Mononitrophenic acid	$C_{12}H_5NO_4O_2$
Binitrophenic acid	$C_{12}H_4(NO_4)_2O_2$
Trinitrophenic acid	$C_{12}H_3(NO_4)_3O_2$

If the acid be strong enough the last compound is alone produced, and when the mixture cools it deposits crystals of picric acid. These are purified by dissolving them in water, neutralizing the solution with carbonate of soda, evaporating, and crystallizing. The crystals of the soda salt yield, when they are decomposed with dilute sulphuric acid, fine

yellow, pearly-looking crystals, or plates of picric acid. They are soluble in from eighty to ninety parts of cold water, and they possess considerable tinctorial power—a grain of acid in 300,000 grains of water will give a moderate shade of yellow to 1,000 grains of silk. The color is best applied with a mordant of alum and cream of tartar; cotton fabrics do not retain the color, and hence it becomes a test for such tissues when mixed with wool or silk. The solution is very bitter, and, as it is not a poisonous compound, it has been thought that it might be used instead of hops for beer. It forms yellow salts with the alkalies, and with metallic oxides, and most of them are highly fulminating or explosive when heated.

If picric acid is submitted to the action of reducing agents it produces red colors of great beauty; thus picramic acid is formed when the acid is reduced by means of a hot solution of protosulphate of iron, (Wöhler,) or by the aid of sulphuretted hydrogen or sulphide of ammonium, (Girard.)

$$\underbrace{C_{12}H_3(NO_4)_3O_2}_{\text{Picric acid.}}+6HS=\underbrace{C_{12}H_5(NO_4)_2NO_2}_{\text{Picramic acid.}}+{}_4HO+S_6$$

The acid thus obtained is in the form of brilliant ruby-red crystals, which are soluble in alcohol and ether, and slightly soluble in water.

Isopurpuric acid is another red product of picric acid. It is procured from it by the process of M. Hlasiwetz, which consists in dissolving two parts of cyanide of potassium in four of water, and when it is heated to a temperature of 140° F., adding little by little a solution of one part of picric acid in nine of water. The liquid evolves ammonia and prussic acid, and, on cooling, deposits an abundant crop of crystals. These are washed with a little cold water, and then dissolved in boiling water to which a little carbonate of soda has been added; as the solution cools it yields tolerably pure crystals of isopurpurate of potash. They have a red-brown color by transmitted light, and a green metallic by reflected. By substituting ammonia for potash, as by dissolving the crystals in boiling water and adding sal ammoniac, there are formed, as the solution cools, beautiful red crystals of isopurpurate of ammonia, which is isomeric with the brilliant red dye called murexide, and which, but for the cheaper forms of aniline colors, would have been an important dye; for it gives to silk and wool, when mordanted with corrosive sublimate, a magnificent purple rivalling the purple of Tyre; and with a mordant of zinc it produces a brilliant yellow. The colors are very fast, but they will not resist the action of the sulphurous acid so constantly found in the atmosphere of towns.

We know but little of the homologues of carbolic acid—namely, cresylic acid ($C_{14}H_8O_2$)—and the higher members of the series, which may, perhaps, be capable of yielding corresponding colored compounds.

NAPHTHALINE COLORS

have not yet been successfully produced, although many attempts have been made to utilize it in this way; indeed, as far back as 1858, Strecker

drew attention to the similitude of chloroxynaphthalic acid and the red coloring constituent of madder, (alizarine,) there being required only the substitution of hydrogen for the chlorine to change it into madder red; and in 1861, M. Z. Roussin announced that he had actually converted naphthaline into alizarine. His process was first to act on naphthaline with nitric acid, and so change it into binitronaphthaline, thus:

$$\underbrace{C_{20}H_8}_{\text{Naphthaline.}}+2HNO_6=\underbrace{C_{20}H_6(NO_4)_2}_{\text{Binitronapthaline.}}+4HO$$

This is a crystalline body, which he next dissolved, little by little, in concentrated sulphuric acid. The mixture was then heated to a temperature of 392° F., and small portions of granulated zinc were cautiously added to it. After a time sulphurous acid began to be evolved, and the nitronaphthaline was slowly converted into a red coloring matter, which he thought was alizarine. The change appeared to be as follows:

$$\underbrace{C_{20}H_6(NO_4)_2}_{\text{Binitronapthaline.}}+H_8=\underbrace{C_{20}H_6O_6}_{\text{Alizarine.}}+2NH_3+2HO$$

By diluting the mixture with eight or ten times its bulk of boiling water, and quickly filtering, the solution yielded as it cooled brilliant red crystals. But they differ from alizarine in many essential particulars, especially in not giving the purple and chocolate tints, as alizarine does, with iron and alumina mordants.

Mr. Perkin has also devoted attention to this subject, but his labors have not been very successful.

Naphthalamine is a compound which bears the same relation to naphthaline that aniline does to benzole, and it is made by somewhat similar transformations. Messrs. Calvert, of the Tower Chemical Works, have produced it very largely, in the hope that, by oxidation in the same way as aniline and toluidine are oxidized, colors might be obtained. In this manner Mr. Brunner produced in Mr. Calvert's laboratory a very fine purple by heating it with arsenic acid. M. Du Wildes obtained a like result with the nitrates of mercury; and M. Roussin has shown how fabrics may be dyed of a red color by acting on muriate of naphthalamine with nitrite of potash, and how a violet red tint may be obtained by heating a mixture of naphthalamine and dry bichloride of mercury in a sealed tube, at a temperature of 350°, for many hours, and by heating a mixture of muriate of naphthalamine and protochloride of tin to a temperature of 472° F. The purple red color is in both cases insoluble in water, but soluble in alcohol, and may be thus used as a dye. Messrs. Guinon, Marnas, and Bonnet have also proposed to use it in the place of aniline for the production of a blue color; but I am not aware that any of these processes have been put into actual practice.

CHAPTER VIII.

STEARIC ACID INDUSTRY.

STEARINE—MANUFACTURE OF CANDLES—IMPORTANCE OF THE STEARIC ACID INDUSTRY—HISTORICAL NOTICE—THE DE MILLY AND MOTARD PROCESS OF SAPONIFICATION—SUCCESSFUL MANUFACTURE OF STAR CANDLES—SAPONIFICATION BY SULPHURIC ACID—SAPONIFICATION BY WATER AND DISTILLATION—SAPONIFICATION BY WATER UNDER HIGH PRESSURE—THE CHANGE OF FATS UNDER PRESSURE, WITH HEAT—TILGHMAN'S PROCESS—DE MILLY'S BOILER OR AUTOCLAVE FOR DECOMPOSING FATS—SAPONIFICATION BY SULPHURIC ACID WITHOUT DISTILLATION—MACHINERY FOR THE MANUFACTURE OF CANDLES—OLEIC ACID—QUALITY OF CANDLES—SOAP—CONCLUSION.

STEARINE.

MANUFACTURE OF CANDLES.

The name stearine does not represent the true character of the substance, (it being stearic acid,) but as it is one accepted by the industrial world, it is proper to retain it. This substance, the result of certain chemical processes, is now manufactured in all parts of the world, and specimens in block and in the form of candles are to be found in Class 44 of almost every country represented at the Exposition. The quality of the product does not vary materially. There seems to be rather a greater range in the qualities manufactured in some countries than in those manufactured in others. In France the demand for quality appears more uniform than in England, for in England a large number of softer candles are in general use, while the universal demand in France is for a hard, white, smooth candle. The principal difference noticed in candle stuffs at the Exposition is that some are a little more mottled than others. This is attributable in part to the difference of the methods of saponification—that made by the sulphuric acid saponification being more mottled than when treated by lime; but my observation convinces me that this defect is principally due to the method and care in cooling the melted stearine before molding. In the character of the stearine products, there is no advance on the Exposition in London in 1862, this being due to the fact that there was hardly anything left to be desired under this head.

If we are enabled to make such beautiful candles out of almost any description of fatty matter, it is entirely due to the application of some of the most interesting chemical results on record; and it is with just pride that France can claim the development of the whole subject from its incipiency to the present perfection of the industrial processes. These labors commenced with M. Braconnot, of Nancy, in separating oleine and

stearine, and were extended through the remarkable scientific researches of M. Chevreul. That these labors deserve to be ranked so high, arises from the fact that they were made at the birth of organic chemistry and on a most difficult class of bodies, about the nature of which there was no correct conception and when the analyses of organic substances had been but just commenced. Still more, M. Chevreul did not give to the world the results of his labors as a mass of isolated facts, but he systematized and classified new acids, new bases, and left to us the chemical history of facts almost as fully made out as they are at the present time; and these have contributed as much if not more than any class of researches to give direction and growth to organic chemistry. The decomposition of the fats and formation of the fatty acids developed the fact that when melted and allowed to cool slowly the more solid acids crystallized out of the mixed mass in such manner as to allow of easy separation of the solid from the liquid part, which fact soon suggested a practical application. Without, however, going into details of all the known processes, so fully and clearly described by M. Strass in the report of the Exposition of 1855, a tolerably comprehensive review of the subject will be given.

In 1823 a complete account of the labors of Chevreul was published; at this period fruitless efforts were made to manufacture stearine, but without success. It was in 1831 that Adolph de Milly overcame the practical difficulties of manufacturing stearine on a large scale, and established this branch of industry on certain principles, some of which have remained unaltered, while others have been materially changed in later years by the same chemist, as will be seen a little further on.

The first countries in which stearine candles were manufactured were France, England, Belgium, Russia, Austria, and Sweden. This manufacture gradually found its way into other parts of the world, and it is now carried on in the remotest places, as Calcutta and Sidney, (Australia.)

IMPORTANCE OF THE STEARIC ACID INDUSTRY.

It is difficult to render an exact account of the importance of the stearic acid industry; nevertheless it can be stated with certainty that the annual production for France is 25,000,000 of kilograms, and approximately for the remainder of Europe is 100,000,000 of kilograms, and for America 10,000,000 of kilograms.

The largest candle factory in the world is that known as the Price Company, having its principal establishments at Liverpool and London, with a capital of 5,000,000 of dollars. Its principal products are what are called the composition candles, of a good quality, but a little greasy to the touch. These candles are used in England by all classes, but would not be received in other countries, where the requirements of luxury are more exacting. The establishments in Holland and Belgium are relatively of great importance, arising from the fact that apparatus, coal, and labor are cheap; the consequence being that these candles are manufactured

cheaply and sold at corresponding prices, and are enabled to be exported more than they are used. As previously stated, from 1831 to 1846 saponification in open vessels by lime was altogether employed; in 1846 another process was introduced, viz: saponification by sulphuric acid followed by distillation. These two processes had their advantages and disadvantages. The saponification by lime gave a small relative yield of candle stuff, but the candles were of the finest quality, having a high melting point; the yield of oleic acid was greater and of a superior quality. On the contrary, the sulphuric acid followed by distillation yielded a larger amount of candle stuff, but of second quality, and a smaller yield of liquid matter of inferior quality. The industrial world employs one or other of these methods, according to the requirements and circumstances governing the demand and the nature of raw material employed. In some countries smooth, white, dry candles of a light melting point and of the first quality are required, while in other countries, attracted by the low price, a candle is used that is yellowish, soft, and greasy to the touch, with a low fusing point. For this reason, France, Germany, Russia, Italy, Spain, and Portugal still employ the lime saponification, and Belgium, Holland, England, and America adopt the sulphuric acid to a great extent. As regards the profits of the two methods they are about balanced, because one class of manufacturers sell at a higher price for products of a better quality but smaller yield, while the other class sell an article at a lower price but of an inferior quality. But it is an observed fact that those who manufacture by sulphuric acid and distillation do not meet with the same commercial success as those manufacturing by lime.

There were forty or fifty factories that exposed products arising from the treatment of fats. Of these about thirty were French. Nineteen of these employed the old lime saponification with fourteen per cent. of lime; three by the closed autoclave under pressure with a diminished quantity of lime; one by the sulphuric acid saponification; two by water decomposition under pressure, and five by different methods of distillation. The more modern method of saponifying under pressure is gradually coming into use, and Messrs. Perré & Son, of Elbeuf, exhibited beautiful products made by that process with the apparatus invented by Rennet.

ACCOUNT OF THE STEARINE INDUSTRY.

The first persons who thought of applying the fatty acids for the purposes of illumination were Gay Lussac and Chevreul. For this purpose they took out a patent in January, 1825, which patent specified "that they reserved to themselves the exclusive right of preparing fatty acids for illumination, both liquid and solid, such as are obtained by saponification of the fats with *potash, soda, and the other bases, by the acids or by any other means.*

"We saponify the fats either at the ordinary boiling point with the *pressure* of a single atmosphere, or at a more elevated temperature with

the pressure of several atmospheres. We have recognized that the saponification conducted in this way has great advantages over that conducted in the ordinary way under a single atmospheric pressure, 'the saponification being accomplished with the smallest possible quantity of alkali. We separate the stearic and margaric acid from oleic acid by the following processes:'"

This is done by several processes detailed in the patent, but the one essentially practical is by decomposing the soap with acids, and, by pressure, separating the solid from the liquid acids. It will be seen that this process is deduced directly from the theoretical researches of Chevreul, with the important exception in relation to saponifying under high pressure.

The process of Chevreul and Gay Lussac was not considered at the time capable of being brought into practice in the arts, from their using potash and soda, thus making the product a very expensive one.

Besides the above difficulty in the original development of stearic industry, another arose in the very commencement, viz: that when candles were made with the ordinary wick they burnt very imperfectly, and the inventors above referred to devised wicks of peculiar description that answered the purpose more or less perfectly. But prior to them, J. L. Cambacérés devised similar ones, and subsequently improved upon them, and finally settled upon the plaited wick now in common use in all stearic acid factories.

The next important step in rendering the stearic acid industry a success was also made by M. Cambacérés, viz: the separation of the oleic acid by powerful pressure, first on the mixed acids cold, and subsequently warmed; and he established a factory in Paris to carry out his process, but this soon failed, from the inferior nature of candle-stock produced and the expense of its production, potash being employed by him as the agent for decomposing the fats.

For several years this industry was abandoned as being a difficult and unprofitable one, when, in 1829, two young physicians, De Milly and Motard, took the subject up, and, after two years of laborious and persistent study of it, accomplished the problem of the successful manufacture of candles from the fatty acids. It is only simple justice to say that the names of Chevreul and De Milly go side by side in this industry, the first in his theoretical discoveries, and the latter in his ingenious and successful devices in the accomplishment of great practical results. Nor is it too much to rank De Milly nearly as high as Leblanc for endowing chemical industry with an art so thoroughly perfected by him and leading to such important economical results in the every-day wants of the civilized world. France may well be proud of having given to the world the art of making soda by Leblanc, and that of making stearic acid candles by De Milly.

The success in making these candles depended first on the discovery of an economical means of saponification. This means consisted in the

employment of lime to replace potash or soda, which method had been indicated in the original patent of Gay Lussac, but no one had solved the problem successfully until it was done by MM. De Milly and Motard, in 1831, in a factory established by them near the *Barriere de l'Etoile* at Paris, and it is from the locality of this first factory that the almost universal name of "star candles" has been derived.

In the original method of saponifying by lime, De Milly and Motard conducted the operation in a closed vessel, under pressure, but from the difficulty of proper manipulation during the operation, it was abandoned, and afterwards carried on in an open vessel at the temperature of 100° C. We do not intend to go into any detail as regards the process already so well known and described in works on technical chemistry, but simply to give a rapid sketch of its history and development.

THE DE MILLY AND MOTARD PROCESS OF SAPONIFICATION.

After the lime soap is formed, it is decomposed by sulphuric acid, and the resulting fatty acids are cooled in shallow tin or copper pans, in rooms of about 60° F., so as to allow of the proper crystallization of the solid acids. The next step is to press these acid cakes, which is first done in a cold press, then in a hot press, first suggested by Cambacérès, but successfully carried out by the horizontal presses invented by De Milly and Motard, and now universally employed in candle factories.

The difficulties, however, of these indefatigable manufacturers were far from being overcome; the pans colored the fats with iron, the last trace of lime was not removed, and the candle made had a crystalline structure. By the alternate application of steam and dilute sulphuric acid, and white of egg and oxalic acid, they overcame the first difficulty. Various means were tried to prevent the crystalline structure, commencing with the objectionable use of arsenious acid, then the more expensive one of wax, which also had a tendency to color the candle; they at last triumphed over this difficulty by cooling the acids to a temperature near their point of solidification before introducing them into the molds that were first raised to the temperature of the cooling fats. During the cooling of the mass it is constantly agitated, and a pasty liquid is produced, which congeals in the molds without crystallization. Three years had now elapsed since the first establishment of their factory, the commercial results of which had been a failure. M. De Milly now came into the possession of the factory alone, his faith in its success remaining firm, and two years later, in June, 1836, he gave the perfecting touch to the successful manufacture of *star candles*. The wick has always been a source of great annoyance in the burning of the candles, for the small amount of mineral matter in the candle stuff would accumulate in the wick, and interfere with the free flowing of the melted fat. After numerous trials by saturating the wick with different substances, the required result was successfully accomplished by impregnating the wick with a certain quantity of boracic acid, dissolved in water, containing

one-thousandth of its weight of sulphuric acid. The boracic acid, as the combustion of the candle progressed, united with the lime and the ashes of the wick, forming a very fusible salt, which accumulated on the end of the wick, forming a small drop.

With this last application *in* 1836 *is to be dated the complete success of the stearic acid industry.* The civilized world recognized it as such, and factories sprang into existence in various parts of Europe and America. Since then there have been some minor perfections in the above process, known as the *lime saponification process.* There have been, however, other processes put in practice for bringing about the same results that will be passed in review, viz:

1st. Saponification by sulphuric acid and subsequent distillation.

2d. Saponification by water combined with distillation or glycerine and fatty acids.

3d. Saponification by water under pressure.

4th. Saponification by water under pressure with a very minute quantity of lime.

5th. Saponification by sulphuric acid without subsequent distillation.

SULPHURIC ACID SAPONIFICATION.

This method was discovered by Chevreul in his original researches on fatty bodies, and in the patent taken out by him in conjunction with Gay Lussac in 1825, this method is specified, but certain portions of the fats were so altered as to discolor the product to such an extent as to render it of no use in practice. The acids, however, thus formed, could be distilled more or less perfectly, as first shown by Chevreul, and subsequently practically executed by Dubrunfaut. But the first idea of combining the two operations, viz: sulphuric acid saponification followed by distillation, is due to Coley Jones and Wilson, of England, subsequently perfected by Gwinne and Jones.

The process as it is now carried out may be summed up as follows: The fat is placed in large vessels that may be of wood or masonry lined with lead, and from six to fifteen per cent. of concentrated sulphuric acid is added; the mixture is then heated by a steam coil to near the temperature of boiling water, and maintained at that temperature eighteen or twenty hours. Some, however, operate at a higher temperature, and consume less time in the reaction, with as much as thirty per cent. of sulphuric acid and agitation, decomposing batches of two hundred pounds in four minutes. The fat is decomposed with an alteration of part of the glycerine and part of the fat, sulphurous acid and carbonic acid being evolved. The black mass resulting from the action of the sulphuric acid is now thoroughly washed by boiling water, until all the fatty acids are freed completely from sulphuric acid. The fatty acids are now introduced into large cast-iron stills, capable of holding over one ton of these acids. The stills are heated

from below, so as to bring the contents to the temperature of 260° C., when a jet of superheated steam of 350° to 380° C. is made to traverse the charge, and in about twelve hours the matter is distilled over, leaving behind a pitchy substance, which may be used in the manufacture of gas, or for coating roofs and other purposes in the arts. The fatty acids when distilled may be cooled in pans, and submitted to the cold and hot pressure; for some purposes it is submitted only to the cold pressure, and in England much is used without any pressure at all, when palm oil has been the fat acted upon.

This method contrasted with the lime saponification has its advantages and disadvantages; among its advantages are the facility of using common and refuse fats, and in giving a larger yield of candle stuff; among its disadvantages are the inferior grade of candle stock produced, and the actual loss of about ten per cent. of the fat by decomposition into gaseous and pitchy matters.

The comparative yield of lime and sulphuric acid saponifications in candle stock from tallow and palm oil is forty-seven per cent. for the lime, and sixty-two per cent. for the sulphuric acid.

SAPONIFICATION BY WATER AND DISTILLATION.

The decomposition of fats by the increase of temperature and the subsequent distillation of the fat acids was originally observed by Chevreul, and different methods were devised by Moses Poole and by Gay Lussac, as early as 1828, to obtain practical results from it, but so much acroleine was formed that it was abandoned as impracticable. Dubrunfaut revived the method, and was more successful; but it was reserved for George Wilson, of the Price Candle Works, near London, to solve the problem in 1852, at least so far as palm oil was concerned; and 1855 he had three stills in operation, each of a capacity of about 1,600 gallons; from which, by one and the same operation the fat acids and glycerine were distilled over uncombined.

To accomplish this two-fold result, viz: to accomplish the watery saponification of the neutral fats, and the distillation of the fatty acids and the glycerine that result from the saponification, it is necessary to heat the fat in a still to a temperature between 290° and 315° C., and to pass through the heated fat a current of superheated steam, properly subdivided, having a temperature of 315° C. For proper success in the operation, the distillation must be conducted between 290° and 315° C., as otherwise the distillation is very slow, or acroleine is produced. This distillation goes on slower than when the fatty acids already formed are acted upon, the latter being accomplished in one-half or one-third the time. The glycerine distilled is of a good quality, and admits of further purification, thus forming the widely known and much appreciated *Price's glycerine.* It is well to state here that the employment of other than palm oil in this process gives unsatisfactory results, and consequently its use is limited.

SAPONIFICATION BY WATER UNDER HIGH PRESSURE.

The conception of this method, in common with all the methods of saponification of fatty bodies, is to be referred back to the author of the discovery of the true nature of fats, M. Chevreul, for in his original researches he pointed out the perfect analogy between the fats and the compound ethers, the latter class of bodies being decomposed with their two constituents in the presence of water heated in close vessels under pressure; a reasonable deduction from which was that fats would undergo an analagous decomposition. This, however, was not undertaken at the time, but, by an accident about the time of Chevreul's researches, it was first observed to take place by Faraday when his attention was drawn to some changes in oils used by Perkins in his curious steam-engine that employed very hot water. Faraday records the facts as observed by him in the Quarterly Journal of Science, Literature, and the Arts, published in London in 1823, vol. xvi, page 172, as follows:

"*Change of fats in Perkins's engine by water, heat, and pressure.*—Mr. Perkins uses in his steam cylinder a mixture of about equal parts of Russia tallow and olive oil to lubricate the piston and diminish friction. This mixture is consequently exposed to the action of steam at considerable pressure and temperature; being carried in by the steam it is found in the water, giving rise to peculiar appearances.

"The original mixture is solid at common temperature, but fuses at about 85° F. When boiled in alcohol a small portion dissolves. The water as it issues from the end of the ejection pipe into the tub placed to receive it and from which it is pumped up again into the generator, appears white and translucent, after having been used, sometimes resembles, very much, thin milk. A scum is found floating on it which, when collected together, forms a solid mass, but when it has been long exposed to the action of steam, and at a high temperature, it has very nearly the consistency of wax. It is always black and dirty.

"A portion of this substance was digested in hot alcohol and the clear solution set aside; floculi separated in abundance from it in cooling, which, when dried and collected and fused, gave a grayish substance, contracting and cracking as it cooled, with the luster and appearance of wax, but rather more brittle. It does not melt in boiling water, but at a higher temperature melts and ultimately burns like wax. It is rather lighter than water; it dissolves readily in alkalies, more readily, I think, than fat, and in this respect *resembles Chevreul's acids of fats* as well as in its solubility in alcohol. The alkaline solution is turbid. It is not soluble in ether, or very slightly so; when burnt, it leaves an ash consisting principally of carbonate of lime. The cold alcoholic solution on evaporation left a substance similar in many respects, but much softer, even fluid. It burnt in the same manner, leaving a slight ash of carbonate of lime."

The above is sufficient to show that the practical decomposition of

fats by water heated under pressure was accomplished as far back as 1823, as any chemist will conclude from Faraday's observation made at a time when we were much less endowed with facilities for research than we are now. No attempt was then made to draw any practical results from these observations, and we find no further notice taken of the subject until early in the year 1854, by R. A. Tilghmann, of Philadelphia, when patents were taken out by him for decomposing fats mixed with water and superheated in vessels of a certain description, the sum and substance of which method is embraced in the following portion of the specifications.

TILGHMANN'S PROCESS.

He mixes the fat on which he operates with one-third or one-half its volume of water and the mixture is placed in some convenient vessel in which it can be submitted to heat equal to that of melted lead, and kept at that temperature until the operation is complete. The vessel is to be closed so that the requisite pressure can be applied to prevent the water from being converted into steam. The result of the action is the splitting of the fat into fatty acids and glycerine, which can be readily separated, mechanically, and both prepared for market. The acids are cooled in the ordinary way and submitted to pressure to procure candle stuff.

The method of Tilghmann, as originally patented, was never introduced into practice; since then, with change in the manner of operating and in the nature of the boilers, it has been successfully conducted in many factories.

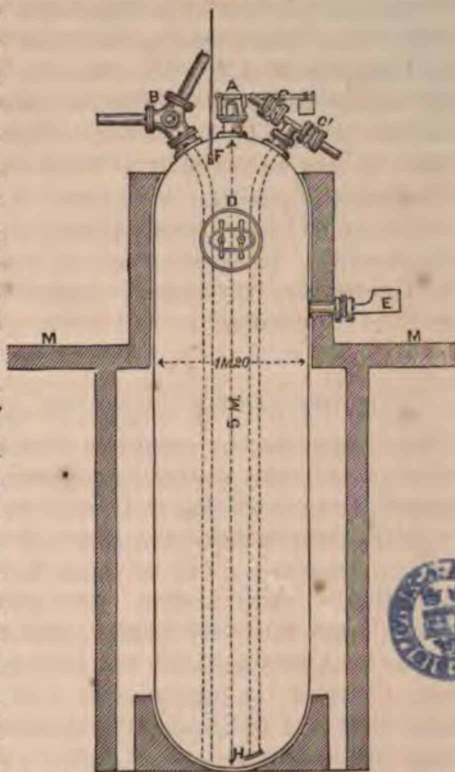
In the latter part of the same year that Tilghmann's process was patented, M. Melsens, of Belgium, took out a patent very analogous, using fats mixed with water in the proportion of twenty to one hundred per cent. of the latter; the water might be acidulated with from one to ten per cent. of sulphuric acid, or the addition of salt would suffice; the whole was heated from 180° to 200° C. for several hours. The success of Melsens process was immediate, and it was put into operation on a large scale in Antwerp in vessels holding one ton of tallow, to which was added fifty per cent. of water, and in six hours the decomposition was complete at a temperature of 180° C., (ten atmospheres.) The fatty acids thus made were of a very satisfactory quality, quite as much so as those obtained by other methods of saponification.

DE MILLY'S PROCESS OF DECOMPOSING BY WATER UNDER PRESSURE, WITH A MINUTE QUANTITY OF LIME.

In 1854 De Milly made an important improvement in the stearic acid industry, by heating the fats at a high temperature with a small quantity of lime, much less than is necessary to saponify the fats in open vessels. This method is much more practicable and rapid than that by water alone, and is consequently extensively used, accomplishing almost every-

thing that can be desired in this respect. The construction of the boiler employed by M. De Milly is given from a drawing made from that which he employs in his factory, and it is so simple that it can be understood at once by inspection. A, safety-valve with lever and weights; B, the screw-valve for emptying the vessel; C C′, cocks for introducing the steam; D, man-holes; E, funnel and cock for introducing the materials; F, cock and tube to the presure guage above, not shown; H, a moveable plate of copper that acts as an agitator as the steam strikes it on entering, and at the same time protects the bottom of the vessel from the mechanical action of the jet of steam. The cylindrical vessel is made of copper 15 millimeters thick, 5 meters long, and 1.20 meters in diameter. The ends are rounded, and it is set in masonry, M; the lower portion being dropped below the floor of the factory. The details of the process as carried on with this boiler are as follows: Introduce in the autoclave the fats to be saponified, and a quantity of water equal to that of the fats less the quantity required for making the milk of lime. For the autoclave used by De Milly, (of copper,) the dimensions of which are given in the figure, 2,000 kilograms of fat are employed. The mixture is brought to the boiling point, the milk of lime being prepared with the water that has been retained having added to it from two to four per cent. of lime. This lime mixture is now introduced by degrees into the autoclave, and in such manner as not to arrest the ebullition, so as to obtain an intimate mixture of the fat and lime, forming a kind of emulsion. Everything being thus arranged, the safety-valve is closed, which, however, allows an escape of a small amount of steam, causing a continuous movement in the mass. The steam being let on from a boiler having the proper heat and pressure, the temperature is gradually elevated to a pressure of eight atmospheres, or about 345° F. At this point the flow of steam is arrested so as to maintain the temperature of the fat and lime at this point for four hours. The saponification may then be considered as finished, and the

Fig. 5.



De Milly's Boiler or "Autoclave" for decomposing fats under pressure.

autoclave can be emptied by the proper valves. The subsequent processes of treatment by sulphuric acid, pressure, &c., are the same as for the ordinary lime saponification.

This new method of saponification was received with much doubt, when it was announced in 1855, and but little notice was taken of it; but since that time it is sanctioned by practice, and has been introduced into nearly all the factories where saponification by lime is adhered to, realizing a considerable saving in lime, sulphuric acid, labor, and time. There is also an economy of fatty matter, for the greater the quantity of sulphate of lime that is formed the more fat gets mechanically mixed with it, and is lost. This method is extensively used in Europe and this country. It remains now to speak of a new discovery, made by M. De Milly in the commencement of the year 1866, and which is destined to exercise a considerable influence upon the stearic acid industry.

SAPONIFICATION BY SULPHURIC ACID WITHOUT DISTILLATION.

Fats saponified by sulphuric acid by the ordinary method contain more or less tarry matter, arising from the decomposition of the fats, causing more or less loss in the raw material.

M. De Milly undertook a series of experiments, by which he finally showed that fats could be saponified by sulphuric acid without the formation of tarry matter. This point being established, he further showed that the fatty acids obtained without the formation of tarry matter were identical with the fatty acids formed by the lime saponification. These he submitted to cold and hot pressure under special conditions, and obtained cakes of candle stuff most beautifully white. As to the oleic acid, it is of a dark color, but in no way decomposed; it makes a fine brown soap, or it can be distilled and made white.

M. Balard, in a report on this process, expresses himself in the following terms:

"In the establishment of M. de Milly, the fat is melted and heated to 120° C.; it is then allowed to flow from its reservoir and mix with a stream of strong sulphuric acid, in the proportion of six per cent. of the latter. The mixture is rendered perfect by means of agitation. The action takes place immediately, and is arrested in two or three minutes by allowing the mixture to flow into boiling water, when the sulphuric acid and unaltered glycerine enters into solution and the fatty acids float on the surface, being of a dark color. But, contrary to what takes place in the ordinary method of saponification by sulphuric acid, the coloring matter is completely soluble in the liquid fat acid, so that by cold and hot compression the solid fat acids are obtained perfectly white, ready to be molded into candles. The entire operation can be accomplished in one hour.

"Nevertheless, it is preferable, when the cold pressure has furnished the solid acid but still colored, to melt it again and put into the pans;

then on cooling to submit it to all necessary pressure, when a fatty acid, fusible at 55° C. is obtained, admirably adapted for the very finest candles.

"It is readily seen that a certain portion of the solid fat acid will find its way into the liquid acid, as the crystallizable sugar in molasses; this can be submitted to distillation. Here, however, the distillation, conducted in such manner, only operates on less than one-fourth of the original solid fat, as the other three-fourths have been separated before the distillation. It is evident that the method unites the advantage of lime saponification and the process of distillation. Three-fourths of the acid obtained is fit for the best quality of candles, and the other fourth for a second quality. The yield of solid fat acids by this method, when properly conducted, is greater than by the other method of saponification with sulphuric acid, there being no loss by carbonization."

This new process, which has been carried on for some time in the factory of De Milly, introduces an extreme simplicity into the stearic acid industry. All that is necessary to conduct the operation are a few receivers and two or three hydraulic presses, requiring but a small amount of capital. It is being introduced into various parts of Europe. M. De Milly has taken out a patent in this country, but as yet it has not been carried out practically. This process bids fair to take a high rank among the known processes for manufacturing candles.

MACHINERY CONNECTED WITH THE MANUFACTURE OF CANDLES.

There was nothing under this head exhibited worthy of special notice. Leon Droux showed a new form of autoclave for treating fat under pressure with water, but it appeared to the writer to be inferior to several forms now in use. Leroy & Durand exhibited a new still, in which there was nothing new except a method for regulating the temperature of the superheated steam. There was a square box inserted in the masonry acting as a recipient of two jets of steam, one highly superheated and the other from the steam boiler; both jets were regulated by valves that could be adjusted to admit more or less of one or other flows of steam, thus regulating in a very ready manner the temperature of the steam admitted to the still. Morane and others exhibited molding machinery, but there was no new improvement on the already admirable machines for accomplishing this part of the manufacture of candles.

OLEIC ACID FROM THE MANUFACTURE OF CANDLES.

The employment of this acid formed a part of the original patent of Chevreul & Gay Lussac, viz, to convert it into soap; but when the candle industry was first successfully conducted by De Milly & Motard, they found it impossible to dispose of the oleic acid to the soap makers, they being prejudiced against its use; so these manufacturers in their unconquerable perseverance converted it into soap themselves, and now a soap department is the natural adjunct to every candle factory. This acid

is also employed to replace the oil used in the manufacture of woolen cloth, an application first suggested by Peligot & Alcan. Attempts have been made to procure elaidic acid (a solid oil acid) by well-known reaction of hyponitric acid upon it, thus increasing the amount of fat which can be used in making candles; but owing to the fact that this reaction produces a red substance that becomes mixed with the fat acid, the method has never found its way into industrial chemistry, and the solution of this question is left to future chemists.

QUALITY OF CANDLES.

The following are some of the points to be noticed in forming a correct opinion of the quality of candles:

1st. The nature of fatty matter used in their manufacture.

2d. Their whiteness.

3d. Their transparency.

4th. Their hardness.

5th. Their dryness to the touch.

6th. Their point of fusion.

7th. Their form and their molding.

8th. The nature of the wick.

9th. The nature of the flame: if it be uniform, long or short, well supplied, illuminating, brilliant, with or without smoke.

10th. Does the cupping at the top of the candle burn dry, or is it more or less filled with melted fat?

11th. Is the fatty matter free from mineral substances?

The above list, as made out by Stass, gives all the points worthy of note to furnish a correct idea of the quality of candles. The point of fusion of the best quality of candles, should not fall short of 55° C. The candles from palm oil acids, although giving very excellent light, seldom exceed 51° C., and often fall short of it. To obviate the disadvantages of using the more fusible candles some manufacturers now envelop them in a layer of material that melts at 56° C. This is done in molding them: and while it is advantageous, it is only an imperfect substitute for those made altogether of harder material. The candles made from distilled material give a whiter light than those from lime saponification, but are less fusible and color more or less in contact with the air, for which reason the star candle from lime saponification ranks highest in commerce.

SOAP.

Under this head nothing new was developed, except the use of oleic acid from the new method of De Milly, of saponifying fats by sulphuric acid without subsequent distillation. The detergent property of this soap is not inferior to that of any other, although the color is very much darker. The manufacture of soap increases very rapidly, every day new factories springing into existence in all parts of the world. Mar-

seilles still ranks first in the soap industry, although the inferior fats and oils are used more than formerly. We are indebted for the present condition of this industry to M. Chevreul, as well as for that of stearine candles, which now both go hand in hand, as the candle-maker must be a soap-maker to consume the excess of oleic acid which is formed in the manufacture of candles.

The different makers try to rival each other in the manner of making up the soap for market, both in appearance and size of separate masses. For the consumers the pound lump is more and more commonly used, and nowhere is the appearance of the soap attended to with more care than at the factory of the Barriére de l'Etoile, where De Milly first engrafted soap-making on star-candle making.

CONCLUSION.

This rather lengthy report on the industrial chemistry of the Paris Exposition gives but an imperfect view of what was exhibited under this class; but it is necessary to terminate it here, and refer those desirous of more detailed information on many points to scientific and technical periodicals and reports, in which the chemical products and processes have been specially treated.

To describe the machinery, and to give statistics of separate establishments which manufacture one or more products, would extend this report into several volumes.

The gigantic nature of some of these establishments, and their operations as now conducted, may be seen in the establishment of Messrs. Casthelaz & Co., of Paris. They decompose daily two tons of nitrate of soda by sulphuric acid to furnish the nitric acid they use for the purpose of producing the nitrogen compounds of benzol and toluol, for transforming arsenious into arsenic acid, phenic acid into picric acid, the bichloride of naphthaline into phthalic acid, &c. They transform daily a ton of benzol into nitro-benzol and aniline; they also make naphthaline for the purpose of producing benzoic acid, first forming phthalic acid from the bichloride of naphthaline. The phthalate of ammonia, distilled, gives phthalimide of lucuine; distilled with powdered lime, the phthalimide produces benzonitrile, and benzonitrile distilled with caustic soda gives benzoate of soda, from which hydrochloric acid precipitates benzoic acid. Attacked by nitric acid, the bichloride of naphthaline leads to an oil and forms binitrated chloride, or binitro-chloroform of Berthelot, of which the odor is so penetrating and the action on the eyes and respiratory organs so terribly deleterious. A few grams are sufficient to cause the most painful burning to a thousand persons.

DESCRIPTION OF THE PLATES.

PLATE I.

GENERAL PLAN OF VITRIOL WORKS.

This plan is designed to show what is regarded as the most convenient, compact, and economical arrangement of the various buildings, storehouses, and parts of the apparatus of works for the manufacture of sulphuric acid. The space covered is about one hundred and fifty by one hundred and seventy-five feet, and the drawing is intended to be on a scale of one-sixteenth of an inch to one foot, but in reducing by photography from the original drawing it has been made slightly smaller. The lot, or ground, beyond the boundary wall, on the side opposite to the main entrance, should be owned by the establishment, and be held in reserve for other chemical purposes, or for an extension of the works, especially for another set of pyrites furnaces and chambers, as they would be conveniently close to the steamers and platinum apparatus, and could be added without disarranging the other works.

PLATE II.

ELEVATIONS AND SECTIONS IN DETAIL OF WORKS FOR MAKING SULPHURIC ACID.

This plate shows the construction of the chambers, the vent column, and the chimney, upon a scale of one-eighth of an inch to one foot. The position of the sulphur furnaces is shown, but they are not represented in detail on this plate, (see Plate IV.) A section of the "furnace column" is given, however, and its connection with the chamber is shown. The figures at the right of the chimney shaft represent the timber framing of the side and of the top of the chamber.

THE FURNACE COLUMN.

The furnace column, seen beyond the sulphur furnaces, is shown in section; this cools the gases from the furnace, and supplies them with nitrous gas and with steam, while it renitrizes the liquor from the vent column and reconcentrates it. It is built square, both the lead work and timber framework measuring six feet on a side; the framework is diagonally braced to give it strength; the column is lined with fire bricks closely built together, but not cemented; the brick work is built fourteen inches thick to a height of six feet above the center of the inlet

pipe; for the remaining distance above this it is only nine inches in thickness, and stands throughout the whole height two inches free within the lead work, which weighs twelve pounds to the square foot. The arch above is groined, with ample rise, as represented, and its bricks are spaced four inches, making quarter bond; their inner edges are chipped, to make the liquor drop clear from them instead of trickling down the abutments.

THE CHAMBERS.

The position of the chambers relatively to each other and to the other parts of the works is shown at the left-hand end of the plate. Chamber No. 1 is shown in section at one end of its principal studs. The figure of chamber 2 shows the framing of the end, and the manner in which it is diagonally braced to chamber No. 1. These chambers are 24 feet wide and 16 feet high inside, at one side, and 15¼ feet high at the other, the difference being due to the slope of the roof, which is 9 inches in 24 feet. The roof joists are of pine, 3 by 9 inches. There are twenty-four joists of 26 feet in length, and five of 30 feet in length. The studs of the sides and ends are 5 by 2½ inches, and 5 by 5 inches, and the diagonal braces are 5 by 3 inches. The sleepers or sills are 4 by 9 inches. Other dimensions are given upon the plate.

In the view of the framing of the side of the chamber the studs are shown placed three feet apart from center to center. The "bays" or spaces between these studs are divided by two horizontal pieces, so placed as to divide the space into three equal parts on the highest side of the chambers, and on the lowest side, under the eaves of the roof, the top third, only, is shortened by the difference (nine inches) between the height of the two sides.

Each chamber floor is fifteen inches higher than that next below.

These chambers are supported upon brick foundations rising about eleven feet above the surface of the ground. The bricks are laid in piers about eighteen inches square, and the work is stronger and more economical if laid in half-bond, with a course of headers between every five courses of stretchers in the nine-inch work; and all the chimney bond, *i. e.*, hollow four-inch work, should be half-bond to form the piers.

THE VENT COLUMN.

This is shown in section at the side of chamber No. 1. The nitrous gas which escapes from the vent is absorbed in this column by means of sulphuric acid "brown," or eighty per cent. acid. The specific gravity of the acid used is generally 1.712, but 1.65 to 1.75 will do. The timber framing of the vent column, which should be diagonally braced all the way up, consists of four tapering pine poles at the four corners. The internal dimensions of the vent column are, at the bottom seven feet square, at the top, on a level with the cistern, five feet square. It is cased in the inside with weather-boards, painted white. These are better than tarred boards.

The lead work consists of cylinders four feet in diameter and six and one-half feet in length; including the flanges they are seven feet, which is the width of a sheet of lead. The full height of the column should be such as to enable it to contain forty-five feet depth of coke. It is represented in the drawing rather shorter than it ought to be. The three lower cylinders, or nineteen and a half feet of the length of the column, should be of lead, weighing twenty pounds to the square foot; the two next, or thirteen feet of the column of lead, weighing fourteen pounds to the square foot; and the two next, or the two highest cylinders of lead, weighing eight pounds to the square foot.

This apparatus, charged with lumps of coke, some very large, is much used and highly esteemed by some of the best makers of acid. On this account it is here shown in detail, the object being to give descriptions of the best existing apparatus, and the methods used by large manufacturers, irrespective of the plans thought better by individuals, but which cannot be considered as established in the trade. The accompanying plan has, however, several faults, which must not be overlooked. The massive leaden structure is expensive and inconveniently high. Its want of permanence is, however, the most serious evil, occasioning costly renewals and troublesome delays in the work. The acid, which is strongly charged with nitrous gas, and the electro-negative coke, coming in contact with the lead, causes its comparatively speedy destruction, and necessitates from time to time a total renewal of the column. To obviate these difficulties, a column of brick is sometimes placed inside the leaden one, and the interior of the brick column is heated and coated with pitch before the coke is put in. The objections to this plan are not so great as to the other. There is, however, a small, compact, and perfectly indestructible substitute, tested by several years' use, though it is not much known to acid manufacturers. It consists of two columns, three feet in diameter each, and about seven feet in height. The depth of the active condensing material within is equal to the height of the column. This consists of clean, rounded, purely silicious pebbles or coke, (but the former is preferable,) screened so as not to be smaller than one-third of an inch nor larger than two-thirds of an inch in diameter. Within these columns no timber framing is needed. The structure, pattern, and material are peculiar but simple. They have been made solely by Messrs. Cliff & Co., manufacturers of chemical ware, Lambeth, London, who usually have some in their ready-made stock.

THE CHIMNEY SHAFT.

If bricks are dear, the walls can be constructed about one-half the thickness here given. The form of the shaft is circular in section, and more conical and tapering than chimney shafts usually are. This is of great advantage, as much less care is necessary in preparing the foundation, for an inch of inequality in its settling cants it over less than if the base were smaller. There is also less liability of the structure set-

tling. It resists storms much better, and holds itself together without iron hoops when the acid fumes or other causes cause it to crack vertically. The size of the chimney at the top is no larger than is necessary for the free escape of the gases. This prevents the down currents of cold air when there are few fires at work, and consequently but little motion of air in the chimney. The form of the top of the chimney is such that the wind increases the draught instead of making it uncertain and variable, or even downward, as is often the case in gales of wind with plain-topped chimney shafts. The top is composed of fixed troughs, radiating all around the orifice conically downwards at an angle of forty-five degrees, so that the wind striking against the top is carried upwards instead of glancing off sideways and "splitting," as it is termed, on the edge of the opening.

PLATE III.

PYRITES FURNACES.

The construction of the pyrites furnaces is shown on this plate by a general plan, on a scale of one to twenty-four; a vertical section through the middle of the furnace at right angles to the front, (cross section,) and a section through the middle, (a longitudinal section,) in a plane parallel to the front; and also a front view or elevation.

Many of the details of construction are explained upon the plate.

This construction of furnace is better adapted to rich Spanish ores (sulphide of iron with a little copper, and not much earthy matter) than to common poor pyrites, (sulphide of iron, with lime, silex, alumina, and frequently arsenic in quantities.) This kind of ore needs a larger furnace, a great mass of fire, and to be burned gently, so as not to flux it. The furnace should never be very red hot in any part of its interior, and the form should be different from that shown in these designs, and should either be cylindrical or enlarging downwards, instead of small at the bottom and enlarging upwards.

REMOVAL OF ASHES—CHARGING.

The ashes are ground out of the furnace by working the bars round and reversing the motion occasionally, so as to make room for the required charges. The charge is one and a half hundred weight (168 pounds) each hour; no more than this is to be put in at one time. The draught of the furnace should be properly regulated, so that it may burn at the required rate; the rate may be more or less than an hour's interval for each charge, but an hour causes good elimination of the sulphur; if a different rate is required, the frequency of the charge may be altered, but not the amount.

REGULATION OF THE DRAUGHT.

The draught of each of the furnaces in the row is regulated by a twelve-inch square tile placed over the nine-inch square hole in the top of the groined arch of the furnace. The position of the tile is changed by means of a rake inserted through the back door way of the nitre oven. The draught is also regulated by means of the ash-pit, by closing it more or less by a flap of sheet iron or by bricks or ashes. This is done partly to regulate the draught, but chiefly to retain the heat of the under side of the pyrites resting on the bars.

The mass is poked and lifted through the small doorway below to prevent its becoming agglomerated by fluxing, or so hard or compact as to impede the passage of air through it.

GRATE-BARS AND LINING OF INTERIOR.

The rests for the grate-bars are forty-eight inches long, five inches broad, and one inch thick, and are set on edge. They are perforated with holes three inches apart from center to center, and large enough to just receive bars one inch square. The parts of the interior most exposed to the fire are lined with fire bricks to a depth of from four and one and one-half to nine inches.

PLATE IV.

DETAILS OF SULPHUR FURNACES AND STEAMERS.

In this plate the sulphur pans are shown in plan and sections, together with the sliding door, and the details of the cast-iron front, and also the details of construction of the steamers and their covers.

SULPHUR PANS.

Figure 31 is a plan or vertical view of one of the sulphur pans, and Fig. 32 is a longitudinal section showing the construction of the front and back. Fig. 33, an elevation as viewed from behind, with a vertical cross section of the pan in the plane of the two screw bolts, six and one-fourth inches from the front of the pan.

STEAMERS.

A, B, and C, in Fig. 34, are cast-iron plates placed horizontally one over each sulphur furnace. Each plate supports a leaden steaming pan. E and F are cast-iron plates set on edge between A, B, and C to support the sheet lead forming the sides of the pan. These sides are folded over the top edges of the plates E F.

STEAMER COVERS.

The steamer covers are drawn to one-fourth of their actual size, together, also, with the brick division wall separating the pans.

CAST-IRON DOOR.

The cast-iron sliding door represented on this plate is intended for the furnaces, and is particularly referred to in the description annexed to Plate V; it is shown in section in two directions.

PLATE V.

CAST-IRON WORK FOR COAL OR COKE BURNING FURNACES, AND FOR THE NITRE-POT OVENS.

CAST-IRON WORK OF THE FURNACES.

Figures 1 to 11, inclusive, show the details of construction of the cast-iron work of the furnaces. The sliding door is shown upon Plate IV. It is so formed that it will suit, without any alteration, all the furnaces throughout the works. It is here shown as adapted to the parallel fire-tiles at the sides, and to a dumb-plate below, as required for furnaces in the department for concentrating and rectifying the acid.

NITRE POT OVENS.

The details of the cast-iron work for the nitre-pot ovens are here shown in Fig. 17, 18, and 19. Figure 18 is a vertical section, longitudinally along a medial line. It shows the flue for the reception of the nitre pot.

NITRE POT.

Figures 26 to 30, inclusive, show different patterns of nitre pots.

The medium charge of nitre for the pot represented in Fig. 26 is four pounds. The medium charge of nitre for the pot represented in Fig. 28 is twenty pounds; the greatest charge thirty pounds.

The proportion of acid to be used to every four pounds of brown commercial nitre, with the usual impurity and moisture, is 1.54 pints of sulphuric acid at 154° Tw., or specific gravity 1.770; this is the best strength. When this cannot be obtained, 1.58 pints of acid at eighty per cent. (*i. e.*, 142.4 Tw., specific gravity 1.712) may be used.

PLATE VI.

EVAPORATING PANS, STEAMERS, AND FURNACES.

In this plate the details of construction and placing of the evaporating pans or steamers is fully shown.

Figure 1 is a longitudinal section through the center of the bank along the line A A marked upon the plan. This shows the construction of the furnace, the ash pit, the pan at the bottom to hold water, and the

long flue leading under the eight pans or steamers placed side by side. Figures 2 and 2ª represent a pair of banks in plan. Figure 2 is a horizontal section. Figure 2ª represents the bank in a complete state, as seen from above. Figure 3 presents an elevation or external view of the front of the furnace, and also a section through pan or steamer No. 1, in the plane B B. It shows the interior of the fire place and ash pit. Figure 4 presents an external view of the back end of the furnace bank, with cross section of the flues, and a section in the plane C C, or through pan or steamer No. 9. Figure 5 is a vertical cross section at the middle of No. 3 steamer, with a further part of the bank, shown in oblique projection, in perspective view, with the point of distance very far removed, in order to show the form of one of the hand syphons and its position when in use.

REMARKS UPON THE FURNACES.

The furnace is very simple, but is adapted to economize fuel, and to consume smoke to a great extent when properly stoked. The surface of the fire-grate is made large enough to burn "brise," (sifted cinders,) or other poor kinds of fuel, while doing full work.

A flap of sheet iron should be hung against and cover the upper part of the entrance of the ash-pit, and be so adjusted as to cause a considerable proportion of the air to be drawn through the chinks which ought to be left in and around the door of the furnace. It is preferable to have the ash-pit closed from above, as described, than at the sides.

The bottoms of steamers, which are five feet by six feet, are not level, but slope two inches in the forty-eight and one-third feet toward the furnace; they also slope two inches in the six feet toward the outer sides of the pair of banks. Their sides are also inclined outwards three inches each from the perpendicular on the sides of the bank, and one and three-eighths inch on the sides next to the adjacent steamer.

The iron plates on which the steamers rest should be made of a single piece, one being placed under each steamer. The lower sides of these iron plates rest on small cast-iron wall plates leading to a small gutter, so arranged as to carry off the acid escaping by leakage, which would otherwise be lost, and by entering into the brick work gradually destroy it.

COVERS OF STEAMERS.

The covering boards are one inch in thickness, coated with the thinnest sheet lead, (two pounds per square foot.) They are supported at each end of the steamer by a frame resting on the brick work, and made of bar iron one inch square, likewise coated with lead. A sheet of thin lead hangs from these iron frames, to prevent draughts of air across the steamer. A narrow space is left between the edges of the lowest covering boards and the upper edges of the sides of the steamer, to allow a current of air to enter, which makes its exit at the top of the

cover, where, between the two edges of the cover, a wider space is left, sufficient for ventilation and for carrying off the watery vapor, but not so large as to allow the acid to become cooled by more air passing over it than will remove the vapor, or the heat to escape by radiation, as is the case to a very large extent when the steamers are left without covers.

The apparatus here described has been long in use, and has been found to be both economical, durable, and convenient. Bars instead of plates are used quite often under the coolest steamers. An economy of fuel is undoubtedly effected by this arrangement, not merely by the lead being exposed directly to the action of the heat, but also by the gases as they glide past being retained by the projecting bars. Steamers, however, supported in this way, are more liable to injury from careless treatment, and the arrangement is not to be recommended.

The pair of banks, such as represented, when in moderate work, can concentrate sulphuric acid from 115° Tw., or 1.575 sp. gr., to 154° Tw., or 1.770 sp. gr. It is then ready for rectifying in the platinum vessel, which gives 10,000 pounds of vitriol each twenty-four hours.

PLATE VII.

PLATINUM STILL, HAND SYPHON, AND STEAM JET.

PLATINUM STILL.

The still here represented is from the establishment of Johnson Matthey & Co., manufacturers of platinum, Hatton Garden, London. Two or more were exhibited in the case containing the platinum apparatus sent by this firm to the Exposition.

The body of the still is twenty-eight and one-half inches broad at the base and thirty-six inches at the widest part above. The total height from the bottom to the top of the hood is thirty-eight inches.

HAND SYPHONS.

These are of platinum, and one is shown in section sideways and as it appears from behind. The dimensions are given upon the plate. The figures are about one-fourth of the actual size.

These syphons are capable of being filled or emptied without the usual trouble, and of being carried about without losing their charge. They are more simple than a cupped syphon, and draw from the bottom of the steamer. They deliver freely, and while in use in liquors evolving gases (the steamers sometimes evolve sulphurous and nitrous gas) these syphons, each having an air chamber, retain their charge a much longer time than an ordinary syphon can under similar conditions.

For connecting steamers in the hotter part of the bank, the syphons

need not be made with the air chamber, unless the acid is frequently of very bad quality, containing much gas. The smallest depth of liquor in which this syphon can be charged is six and one-half inches.

STEAM JET FOR CHAMBERS.

Steam jets are made of chemical stone-ware. Those manufactured by the Messrs. Cliff, at the Imperial Potteries, Lambeth, London, are porous, baked at a heat below vitrification, and are not glazed. These withstand the effect of acid gases and the sudden heat of steam, and will maintain a uniform jet of high-pressure steam, which can be regulated by chipping off the indented end of the jet. This jet-hole does not clog or enlarge as with a leaden jet. The conical exterior insures a close fit into a smooth circular hole in the sheet lead forming the top of the chamber, and without enlarging the hole by wedging too tightly into it.

APPENDIX.

COLORING MATTERS DERIVED FROM COAL TAR.

EXTRACT FROM THE REPORT OF DR. A. W. HOFMANN.

"This is no longer an age in which an industry requires many years for its creation, and still longer time for its development and expansion.

"Jealously guarding the processes employed, hiding with care the raw materials used, a manufacturing process formerly was hid in an obscurity which had the effect of confining a profitable monopoly to the country where it was first established. The privileges conceded by the rulers, a host of legislative enactments, general ignorance, and the special organization of labor, all tended, at a period anterior to 1789, to favor this result.

"In our days, a useful discovery is scarcely made, or a happy application of one found out, before it is published, described in the scientific journals or other technical periodicals, and especially in the specifications of patents. It then becomes the starting-point of a thousand researches and new experiments, entered into by the philosopher in the hope of advancing scientific progress, and by the manufacturer with the expectation of reaping a material benefit. From these multiplied and diverse efforts, these incessant labors of an army of workers, arises an industry which has no sooner sprung into existence than it becomes important and prosperous. Moreover, it is not only in the land of its birth where its development takes place; it extends rapidly in foreign countries, so that it not unfrequently happens that the place where the discovery has originated is distanced in the applications of it by neighboring states. The ocean itself is no longer a barrier between the nations which it separates. New York, in an industrial sense, is now a neighbor of London, Paris, and the German centers of industry.

"The history of the artificial coloring matters derived from coal abounds in illustrations of this. It only dates from the end of 1856, and yet what success it had achieved in the Exhibition of 1862!

"From that date, owing to the number, variety, beauty, and value of its products, and from the large scale on which it was carried on, it might rank with the largest industries. In 1862 the value of these manufactures had risen from nothing to ten millions of francs; at the present day this sum is trebled, and still the products are much cheaper

than they were before. Indeed, the improvements successively introduced into the manufacture of the tinctorial products derived from coal have had the result not only of rendering them more beautiful, but at the same time of reducing their cost in such a manner that aniline colors can successfully compete in price with any other coloring matter of equal tinctorial power; so that if they were formerly purchased on account of the unexampled brilliancy of their tints, they will retain their importance owing to the low price at which they can be produced.

"Among the coloring matters which were already known in 1862, some have now become true *raw materials*, from which are produced other coloring matters equally beautiful, equally rich, and of no less importance than those from which they have sprung.

"Thus, rosaniline has become the parent of a whole series of colors, and last of all of a green. The gamut of coloring matters derived from aniline is now complete; we have red, orange, yellow, green, blue, indigo, and violet.

"Are we not justified in saying that the manufacture of artificial coloring matters, in spite of the improvements of which it is yet capable, in spite of the discoveries which will yet enrich it, and scarcely ten years old, has emerged from the state of infancy, and become one of the most important industries of the age?

"But if the development of this new branch of manufacture has attained so high a point in so limited a time, its publication and diffusion through the industrial and commercial world have advanced with still greater rapidity. The first of the aniline dyes in order of date is mauveine. This was discovered in the month of August, 1856, by Mr. W. H. Perkin. Whilst the inventor, young, and of ample resources, remained for nearly two whole years before he could carry out his invention on a large scale, and strove against the difficulties which beset the introduction of all new discoveries, several French manufacturers produced mauveine immediately, and on a large scale, by the actual process (or but slightly modified) which was revealed to them by the English patent. One who only considered the state of the industry at this time in the two countries, would have said that the invention belonged to France, and had only been imported into England. From France it almost at once spread to Germany.

"In 1859 aniline red was produced. Scarcely three months after its production was commenced at Lyons it was transplanted to Mulhouse; then crossing the Channel, it became established in England, at London, Coventry, and Glasgow, and was not long before it was taken up in Germany.

"Aniline blue first appeared in 1860. Less than a year afterwards it took ten manufactories in Germany, England, Italy, and Switzerland to produce this new material.

"While the manufacture of aniline colors thus became European, their consumption spread still further; and now could be observed this

unique fact in the history of commerce: the West supplied the East with coloring matters, sending its artificial dyes to the confines of the globe, to China, to Japan, to America, and the Indies—to those favored climes which up to the present time had supplied the manufactories of Europe with tinctorial products. This was a veritable revolution. Chemistry, victorious, dispossessed the sun of a monopoly which it had hitherto always enjoyed; at the beginning of this century, when mythological language was in vogue, it would have been said that Minerva had triumphed over Apollo.

"But it was not sufficient to extract colors from tar and send them to China; it was necessary to secure a market for them and get their acceptance; and now occurred a circumstance characteristic of this epoch. In order to apply these colors, the processes being altogether different from those followed by the Chinese, and their employment requiring the assistance of substances which were unknown to them, it was necessary to change at the same time their tinctorial substances, their solvents, and their mordants—in a word, to undertake the education of the Chinese dyers. This difficulty did not for a moment stop the European manufacturer; he sent to China and Japan not only the workmen who should teach his customers the way to apply the colors with which he supplied them, but also the chemical products necessary for their manipulation, such as sulphuric acid and absolute alcohol, which were before unknown to them. Thus arose considerable dealings with the East, the quantities sold by European manufacturers in 1864, 1865, and 1866 amounting to several millions of francs.

"The Universal Exhibition of 1867 shows considerable progress in all branches of the manufacture of artificial colors since 1862. It should here be noted that the year of the English Exhibition was itself one of the most fertile in discoveries and improvements.

"Almost immediately after its close there appeared aniline green, the violets of methylic and ethylic rosaniline, and aniline black, and at the same time science was able to dispel the darkness which had hitherto enveloped the production of the new coloring matters. If we wished to generalize, we should say that exhibitions are not only of value in registering acquired discoveries, but still more of inducing and hastening the birth of new inventions. However this may be, we may here tabulate the coloring matters mentioned in the reports of the Exhibition of 1862:

Picric acid.
Isopurpurate of potash.
Mauveine and its salts.
Rosaniline and its salts.
Rosaniline blue.
Rosaniline violet.
Chrysanline, (Phosphine.)
Peonine.

Azuline.
Emeraldine.
Viridine.
Azurine.
Pseudo-alizarine.

"Some of these colors have disappeared from commerce, if, indeed, it is certain they were ever introduced; these are emeraldine, viridine, azurine, and pseudo-alizarine. The consumption of mauveine has diminished considerably, as well as that of the rosaniline violets; but, on the other hand, the importance of rosaniline and of triphenylic rosaniline blue has greatly extended. At that time aniline black only existed in theory, now it is one of the most valuable of this class of colors.

"The following is a list of the coloring matters which, since 1862, have entered, or are about to enter, into commerce, and which figured in the Exhibition of 1867:

Aniline green from aldehyd.
Methylic and ethylic rosaniline violets.
Aniline green from iodide of methyl.
Aniline maroon.
Aniline gray.
Aniline black.
Mauvaniline.
Diphenylamine blue.
Chrysotoluidine.
Naphthalic red, (salts of chloroxynaphthalic acid.)
Naphthalic yellow, (binitro-naphthol.)

"Among these latter substances many are of considerable importance, such as the new greens, the violets, and aniline black.

"But if new colors have been discovered, the improvement of the old ones has not been neglected; their price has been lowered; their extreme purity and beauty, which at the date of the 1862 Exhibition were exceptional qualities, have now become matters of ordinary production; and the healthiness of the manufacturing processes has been considerably ameliorated.

"Corresponding improvements have been effected in the industry of the raw material. In 2862 a large quantity of coal tar was completely lost for the manufacture of artificial coloring matters; although for some time it was collected in certain works, at St. Etienne, for example, thanks to the care and processes of MM. Pauwels and Knab. The problem consisted in transforming the ordinary coke-ovens into vast gas retorts, which while producing the same quality of coke admitted of the collection of the tar and gas; the latter serving to heat the ovens themselves. These apparatus, which the limited scope of our report prevents us from describing, are becoming more generally adopted; they have already exercised a notable influence on the price of the products of the

distillation of coal, and especially on the light oils, although the tar is far from being collected in a complete manner.

"In France three millions of tons of coal are carbonized annually to supply coke for metallurgical purposes. When the process of MM. Pauwels and Knab[1] is more generally adopted there will be collected from this, one hundred and twenty-five or one hundred and thirty millions of kilograms of tar, which would yield two or three millions of kilograms of light hydrocarbons. It may therefore be predicted that the price of benzols will fall still more, and that consequently the cost of coloring matters derived from it will be reduced. These prices are at the present time from seventy to eighty centimes the kilogram for benzol; in 1862 it was worth three or four francs the kilogram. Aniline, which then cost from twelve to eighteen francs, is now worth two and one-fourth francs, or three and one-half francs at the maximum. Crystallized hydrochlorate of rosaniline has fallen from two hundred and fifty to three hundred francs to twenty-five and thirty francs. The blue which was formerly sold at five hundred francs is now offered at one hundred francs, and inferior qualities cost only thirty or forty francs. These figures prove in a most convincing manner the enormous progress realized by the aniline color industry since 1862.

"This reduction in price of the aniline colors is such that all manufacturers who use coloring matters have found it worth while to replace their former tinctorial products by these artificial colors.

"Besides this, the employment of these products has greatly simplified the formerly very complicated and costly operations and processes of dyeing, so much so that an apprentice can now obtain as good shades as a skilled workman; this facility of application has certainly not less contributed to the success of the coal tar coloring matters, than the richness and variety of their shades.

"The employment of these magnificent coloring matters is not confined to dyeing and calico printing. They are utilized in many other industries. Their different applications, the most important of which we shall rapidly glance over at the end of this report, have also contributed to their development, although they only consume a comparatively small amount of these coloring matters.

"The progress which we are about to record in the industry of the coal tar colors shows, in fact, that the probable development of the aniline colors and their economic and commercial results, foreseen by the Reporter[2] in 1852, are to-day accomplished facts. Everything, therefore, leads one to imagine that ultimately the natural will yield entirely to the artificial coloring matters.

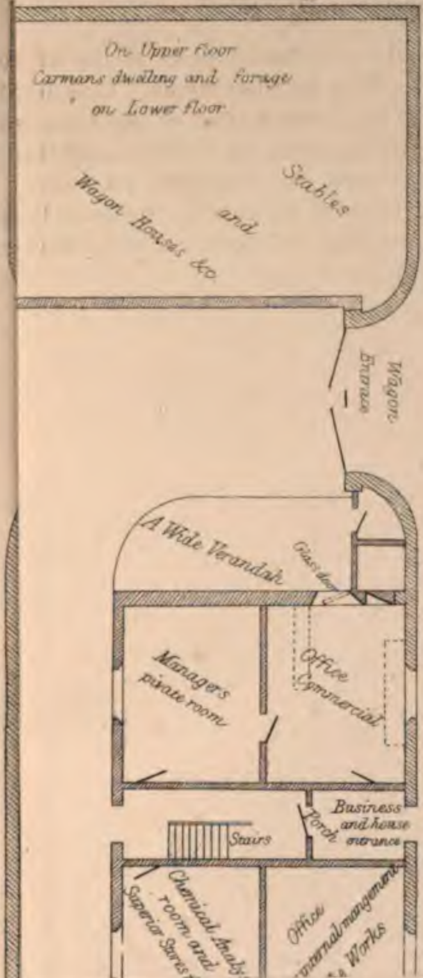
"This revolution, the influence of which will be most important, since it will liberate for the production of food many lands now employed in

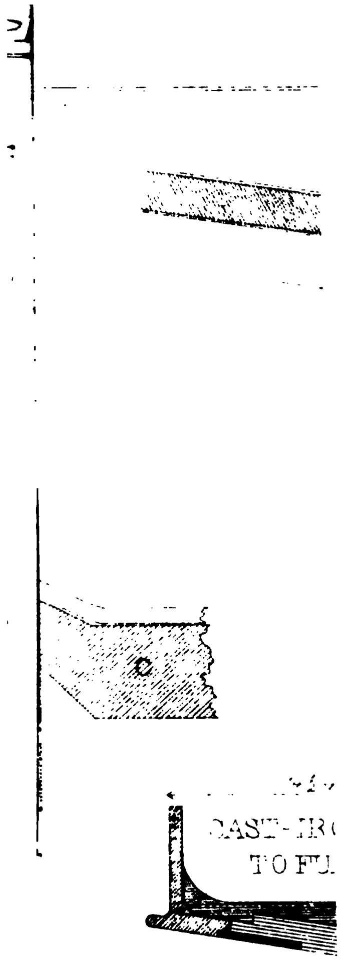
[1] See La Chimie, by Pelouze and Fremy, vol. ii., p. 884. The apparatus of MM. Pauwels and Knab also figure in the exhibition of mines of the Loire.

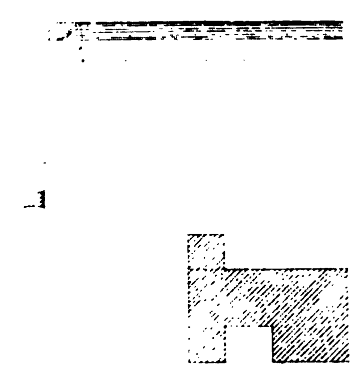
[2] International Exhibition of 1862. Reports of the juries, class2, section A, p. 120.

industrial operations, would already have taken place if the artificial colors hitherto discovered were as solid as their rivals. Less fugitive than when first prepared, owing to the greater state of purity in which they are now obtained, they are still too dear to enter largely into the dyeing of cloth and other textures used for household purposes. On reviewing the history of coloring matters in general, we may be permitted to hope that this defect of stability will soon disappear under the combined efforts of science and industry."

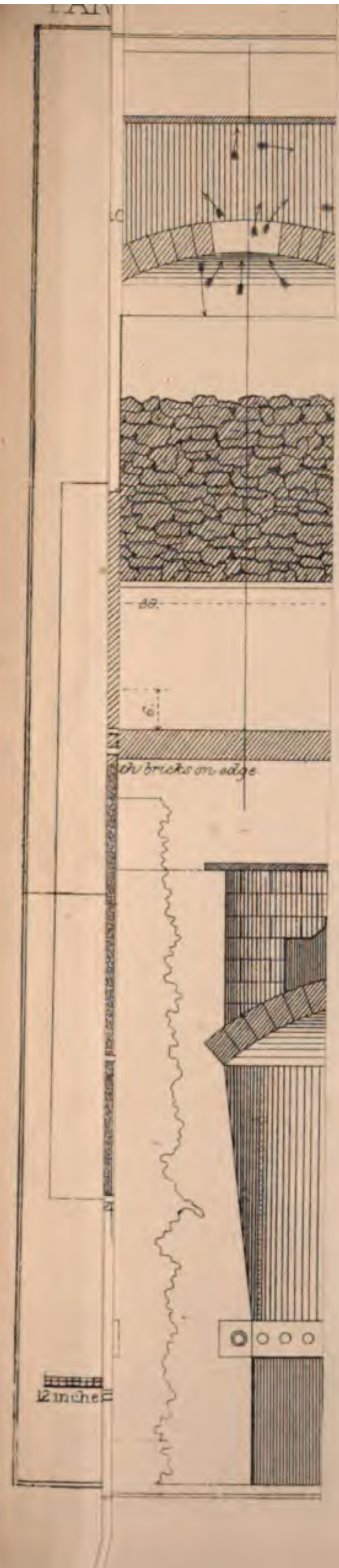
PLATE I


On Upper floor
Carmans dwelling and forage
on Lower floor
Wagon Houses &c
and
Stables
Wagon Entrance
A Wide Verandah
Glass door
Managers private room
Office Commercial
Business and house entrance
Porch
Stairs
Office
Works





The plate B, in se


88.
6.
th bricks on edge
12 inches


PA
Horizontal section, in a plane 6 inches above surface of the pan/
C
14 3/4
CAST-IR
TO FU
The plate B, in se

CAST IF

THE NITR

Fig. :

Horizonta

n plane 6 inches abo